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Editorial.

The Bunchy-Top Disease of Plantains.

FOR some years the bunchy-top disease of plantains has caused considerable damage to the plantain cultivations of Ceylon. This disease was first noticed in Colombo and has subsequently spread to the majority of districts in the Island. In certain districts, its occurrence is still rare and in a few the disease is not yet known. In the Jaffna District of the Northern Province only a few cases have so far been noticed. Tissamaharama is reported to be free and Batticaloa has only a few bunches attacked.

The isolation of certain districts has resulted in their keeping relatively free from the disease and it is possible that the dry climate of Jaffna with cultivation under irrigation may account for the small number of attacked plants there.

Investigations have been carried out for some years on this disease and it has been established in Australia that the disease was insect-carried—being transmitted by an aphid.

Search in Ceylon has shown that this same aphid is present and that it is common on plantations of plantains. Investigations had, however, shown that root disease and certain weevils are also common in Ceylon and might not be unconnected with the bunchy-top disease. A series of variety trials and also field tests of various soil treatments were started at Rambukkana. As the result of these tests, it was found that all varieties tried were subject to the disease but that the Hondarawalu type was the most resistant. It was also found that bunchy-top plants had associated with them eelworms, weevils, root disease and aphids —either singly or in combinations. It was felt that the aphid could not be considered to be the sole victor under Ceylon conditions.

It became clear therefore that more detailed and profound investigations would be necessary, and suggestions for these were being formulated when it was possible to secure a visit from Mr. Magee, the Pathologist who worked on the disease in Australia, during his return passage for Europe. He examined plantain areas and has reported that the Ceylon disease is similar to that found in Australia and possibly also in Egypt and Bengal and that he is of the opinion that it is aphid-carried. Further trials are being devised to test this view and the Mycologist of the Department of Agriculture will undertake further investigations in regard to root diseases.

It is however clear that, if the disease is aphid-carried, it is likely to spread to all districts of the island with the possible exception of some of the drier parts and that even if root disease may play some part in Ceylon in the diseases the only practical control measures are to be looked for in securing immune or resistant varieties. The well-known Ceylon types—especially those which are the most appreciated—all seem to be liable to the disease and their relative resistance has yet to be submitted to further test. Arrangements are now being made to do this, and also to test at the same time the resistant characteristics of some of the standard plantains of Burma and Malaya. It is only after careful tests have been so made, that accurate advice can be tendered to the growers of plantains and it is quite conceivable that grading work may have to be planned in the East on lines not very different from the plans made to work out the problem of Panama disease in the West.

In the meantime, growers in bunchy-top affected areas would be advised to use only healthy suckers for planting out, to cultivate well, to use as much of the Hondarawalu type of plantain as possible and to control aphids if feasible. The Hondarawalu type of plantain, so far, has been found to be the most resistant, but tests have only been made with a small number. In the larger trials now being planned, it is hoped to include all the types of plantains known in Ceylon and when these have been made it should be possible to offer recommendations as to types which can be planted in bunchy-top affected areas.

Opinions amongst departmental officers differ as to whether the disease is becoming more severe. In some districts there has been an increase in the amount of the disease but in others—several of which were a few years ago seriously affected—the disease is reported to be much less common and on the decline. The disease still continues in the aggregate to cause considerable losses and must therefore continue to receive attention from scientific investigators in Ceylon until a " way-out " has been found.

Original Articles.

Modern Field Experiments.

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DURING recent years a great deal of attention has been paid to the methods of field experimentation, due largely to three causes. In the first place, as regards temperate crops, the main features of manuring practice have been determined by such well known experiments as those at Rothamsted and Woburn. Consequently research is now being concentrated on questions to which the answers will be less spectacular. Instead of broad questions regarding the benefit derived from the elementary plant foods, nitrogen, potash, and phosphate, individually, problems of their interrelationship are occupying attention. Moreover with the increase in the variety of fertilisers available, the one form has to be tried out in comparison with several new and alternative kinds. Even though the differences investigated do not exceed ten per cent. they may mean all the difference between profit and loss to a hard pressed industry. Since experiments which would satisfactorily establish the value of nitrogen in general will not usually distinguish which of two forms, for example sulphate or muriate of ammonia, is the better, a new stimulus has been given to attempts to make experiments more accurate.

The second cause of activity has been the forging of a new weapon, that of mathematical statistics. Like all novelties, it has been used both wisely and unwisely, but in the hands of experienced workers it has contributed greatly to the advance of field experimental methods.

Thirdly, the establishment of experimental stations all over the world has brought many new crops and new conditions under consideration, and has enlarged both the scope and difficulty of experiments. The building up of satisfactory techniques for such diverse crops as rice, rubber, cotton, tea, and tobacco, to name only a few upon which time and ingenuity are being employed, is not the work of a moment, but a start has been made.

Amongst recent work of this type, that of the Statistical and Field Experiments departments at Rothamsted has provoked a steadily increasing stream of enquiry. The general statistical principles have been stated by Fisher (2) and examples of the practical applications of those methods have now been published in the Rothamsted reports and the scientific journals (1,3,4,5,6,7,8) The present article is an attempt by one of the collaborators to emphasize the advantages of modern methods and to indicate how they can be profitably applied to a variety of crops and conditions, especially in connection with tropical agriculture.

The Error Basis of Experiments.

The basis of all good field experiments may be simply described as the establishment of representative mean yields, and the assessment of the valid errors of those means. The distinguishing feature of modern experiments lies in the methods by which these two important classes of data are obtained.

It will be assumed in this article that the general concept of a standard error is understood, and that the calculation of such a statistic from the sum of the squares of the deviations of plot yields from their mean is a familiar one. From this starting point we shall discuss the relationship between the statistical calculation and the actual practical experiment.

When replicated experiments were first designed with a view to providing reliable means and errors it was customary to arrange the plots in a definite order by treatments, and the regular chessboard type of experiment came into being. An actual design is shown in the figure.

A	F	C	H	E	K
B	G	D	J	B	G
C	H	E	K	A	F
D	J	B	G	C	J
E	K	A	F	D	H

It will be noticed that treatments A B C D E are always to the left of F G H J K. Such arrangements have obvious disadvantages. In the event of a marked fertility slope from left to right, the unfairness of the comparison between any of the first five treatments and any of the second five becomes serious. Even where care is taken to balance the positions by reversing the order, there are other objections. To elucidate these it will be necessary to consider the effect of varying fertility on the errors as well as the means.

Let us suppose that in any chessboard scheme of this kind the replicates of two treatments A and B have been spaced out so that they purposely sample the admitted fertility gradient equally.

The actual magnitude of the means of the A treatments and the corresponding B treatments would naturally depend upon the steepness of the fertility gradient. If however A and B partook of it to the same extent, as they would under the ideal conditions here imposed, the magnitude of the difference between the means would not be affected. The design has been successful in eliminating to a large extent the soil fertility disturbance from the differences between means of treatments. It is of course these differences which are important and not the actual magnitude of any particular mean.

Now let us consider the errors, confining attention for the present to the error of one mean only. Suppose the numerical values of the individual plot yields of one treatment were 8, 10, 12. Then proceeding with the normal calculation of error we have

	Plot Yield.		Deviation from Mean		Deviation Squared.
	8	...	—2	...	4
	10	...	0	...	0
	12	...	+2	...	4
Total	30				8
Mean	10				

If however the fertility gradient had been less a different result would have been obtained.

	Plot Yield		Deviation from Mean		Deviation Squared
	9	...	—1	...	1
	10	...	0	...	0
	11	...	+1	...	1
Total	30				2
Mean	10				

The mean remains unchanged in this case, but the deviations of the former are greater, and the sum of their squares from which the error is calculated is correspondingly magnified. From this it follows that in such a system as this, the size of error is dependent on the soil fertility gradient, being greater in proportion to the size of that gradient. We therefore arrive at this state of affairs, that the difference between means of treatments is by design independent of soil fertility slope, but the calculation of error is not.*

*The arrangement of plots with regard to fertility slope does not introduce any compensation for the error of the difference between two means, as it does for the differences between the means themselves. This follows from the fact that $(S.E._{A-B})^2 = (S.E._A)^2 + (S.E._B)^2$ for a random sample.

This is one of the failings which is common to all the older types of replicated experiments and to their statistical treatment. There are others inherent in the systematic arrangement, because for the calculation of a valid error a random sample is necessary, and a systematic arrangement is the antithesis of this.

The Analysis of Variance.

The solution to this difficulty of the contribution of soil heterogeneity to error calculation is to be found in Fisher's Analysis of Variance and in the experimental design appropriate to this analysis. For a detailed account of the former, reference must be made to the reference cited (2). The main plan is all that can be stated here. It can be shown by simple algebraic processes that in any experiment

$$\text{Sum of Squares of Deviation } \textit{Total} = \text{Sum of Squares of Deviations } \textit{Treatment} + \text{Sum of Squares of Deviations } \textit{Position} = \text{Sum of Squares of Deviation } \textit{Remainder}$$

By position is meant any disturbing factor which can be identified with the differing positions of the plots. It includes soil heterogeneity and several other factors, but the former usually predominates.

The diagram (Fig. 1) represents an experiment involving twelve treatments in quadruplicate. Each block contains the twelve treatments. The total sum of squares is derived from the deviations of the 48 plots from their mean.

That portion of the total sum which can be ascribed to the variability in treatment is derived from the deviation of the means of individual treatments from the same general mean. Thus with the general mean of M and m_A, m_B, m_C ... m_L as the means of treatments, ($m_A = \frac{A_1 + A_2 + A_3 + A_4}{4}$) one can obtain the values for the twelve deviations $M - m_A$, $M - m_B$, $M_C - m_D$, etc., the squares of these values, and the sum of these squares. This is the sum of squares of deviations due to treatment.

The corresponding value for position depends upon the fact that each quarter block of the experiment has been made to contain each treatment once. The " control " plot is regarded as a treatment as it logically is. If there were no variation due to position (i.e. soil heterogeneity, plant variation, etc.) then the means of these four blocks should be the same. If there is variation, the sum of the squares of the deviations of these block means from the general mean M will be a measure of it. Proceeding in the same way as before, using block means instead of treatment means, four deviations are obtained whose squares when totalled give the required value for position.

Of the four terms of the equation three are thus calculable from the data directly, whilst the remainder is obtained by difference. It is this remainder sum of squares, which suitably treated, will give the true estimate of error. An error is thus derived free from the disturbing influences of soil variation, at least in so far as that heterogeneity is common to all four blocks. Without taking advantage of this method of elimination of the positional variances of the data, the error would be estimated from the combined sum of squares of deviations + sum of squares of deviations. The system, like all valid systems of error determination, requires the arrangements of the treatments within any one block to be a purely random one, decided by assigning to each treatment a card and drawing them one by one out of a hat. This remainder function therefore gives a random error.

position

remainder

It is not proposed to develop further the statistical side of the method here. Three advantages are claimed for it:—

(1) The means and errors of means are by design and statistical calculation freed to a large extent from the disturbing element of soil heterogeneity and are entirely comparable.

(2) The estimate of error is applicable to all comparisons in the experiment. By older methods, the error had to be calculated for each mean and for each pair of comparisons about which information was desired.

(3) By pooling all the replicates of all treatments one derives the error from a larger population with a larger number of comparisons, a fact which in itself makes for a more accurate value.

Practical Applications.

This method lends itself to many practical modifications for it is by no means a "cast-iron" system confined to the randomised blocks in window pane formation which has been chosen in illustration. Numerous elaborations have been worked out, but here the simplest applications only are reviewed. An exception is made in the case of the Latin square.

In an experiment of this form each treatment occurs once and once only, in each row and each column.

Columns

I	II	III	IV		
C	B	A	D	(1)	
B	D	C	A	(2)	
D	A	B	C	(3)	Rows.
A	C	D	B	(4)	

The positional variances can therefore be measured for both rows (i. e. variability from top to bottom) and columns (variability from side to side). These variances are additive and give a most effective check upon systematic soil variation, more complete than if only rows or columns had been so treated, and more effective too than where blocks have been used as above.

Where therefore an experiment has to be done on ground, the nature of whose fertility gradient is unknown, such an arrangement offers the best chance of success, for in whatever direction the fertility varies, it will be caught in the net of either row or column variance.

There are times when it is difficult to lay out an experiment in one block without encountering purely local disturbances. A patch of shallow soil, a group of rocks, a declivity, a patch of resistant weeds; or, in an experiment carrying a general cover crop, a patch where the cover has failed, will often occur to mar an otherwise suitable site. Such occurrences are distinct from anything in the nature of a fertility gradient common to all parts of the experiment. The new method, in such instances, allows of the decentralisation of the blocks to avoid this, without adding to the magnitude of the error or rendering means of treatments less comparable. Comparisons in the last resort are between treatments in the same block. Any exaggeration in the difference between the yields of blocks as a whole, due to having them further apart will not affect the treatment comparison, being, from the error standpoint, eliminated in the positional variance.

The problem of well defined physical or fertility slopes is best met by means of blocks of strips. In such a case the lay-out would aim at making the blocks take advantage of the more pronounced gradient, for, as between blocks, this can be eliminated.

For a greater fertility slope from top to bottom, Fig. 2 (a) would be unsatisfactory unless the gradient were ideally uniform. Even then the uneliminated gradient from left to right would assume greater proportions than in Fig. 2 (b) which is the recommended plan.

Similar considerations are met with in two other important cases, that of irrigated experiments and those suffering from soil erosion.

In blocks of strips under irrigation, there will be a falling off of water supply and water movement in two directions—(a) along the main supply channel and (b) along every sub-channel supplying individual plots. In such circumstances, the arrangement depicted will eliminate variation due to the more serious cause, that of water supply in the main duct, whose variation from time to time is likely to be greater than down the small plots.

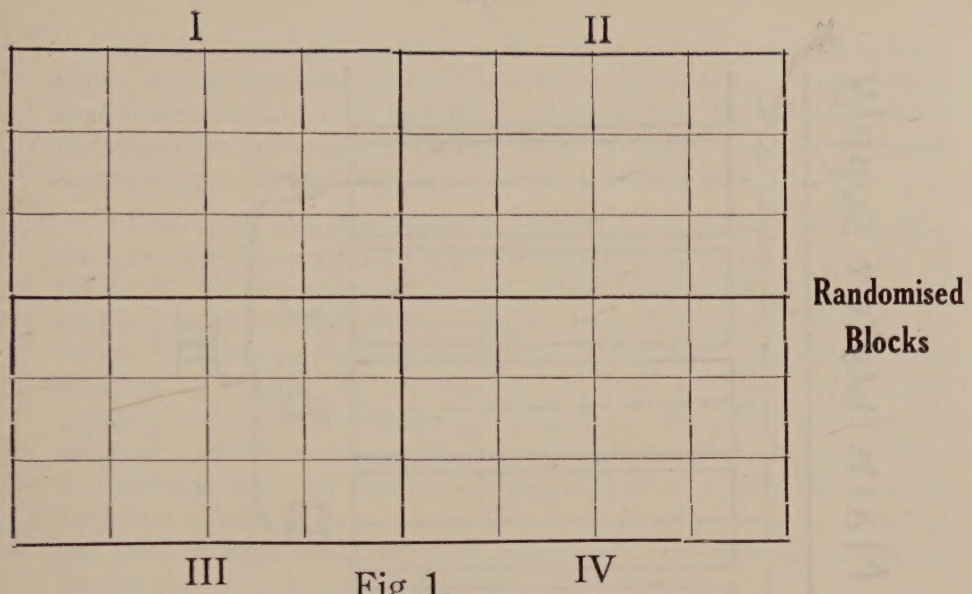
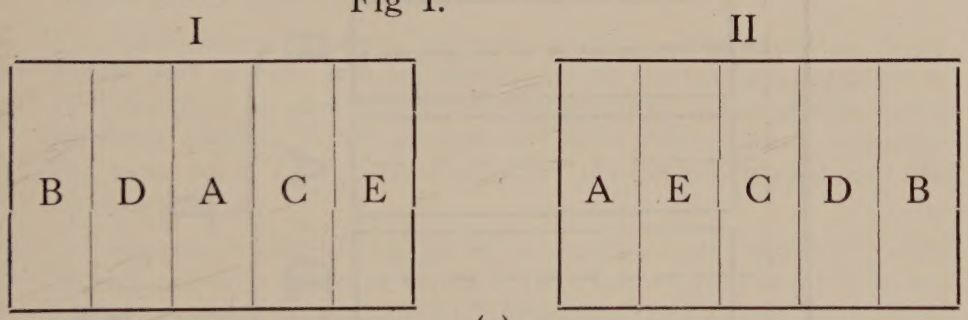
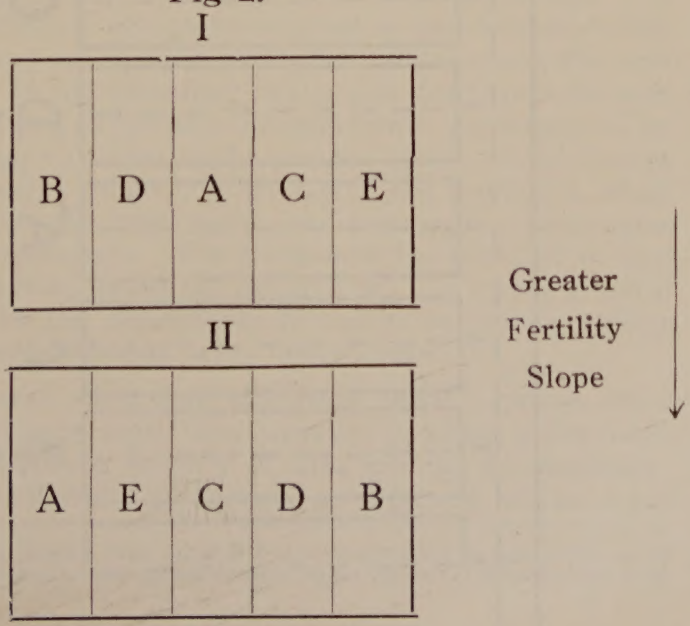

I
II
Randomised Blocks
III
IV

Fig 1.


I
B D A C E
II
A E C D B

(a)

Fig 2.


I
B D A C E
II
A E C D B
Greater Fertility Slope

(b)

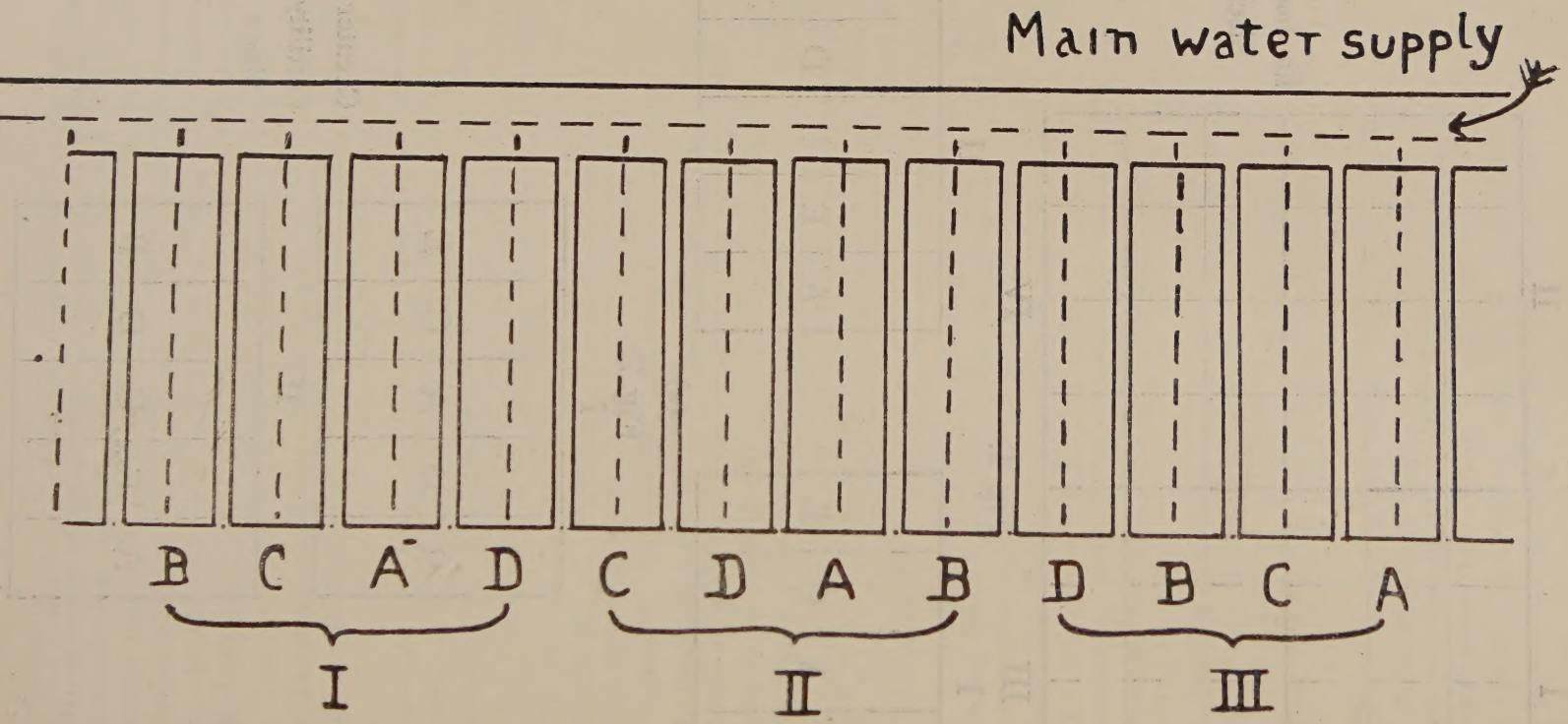


Fig. 3.

In like manner, leaving sufficient space to prevent serious wash of soluble salts, etc., from block to block, a soil eroded experiment would take the form described in Fig. 2 (b) where the direction of erosion corresponds to that marked greatest fertility slope in that figure.

This type of experimental design* is not confined to differences of soil heterogeneity caused by the geographical locality of the plots. It offers a satisfactory solution to the vexed question of tapping error in rubber experiments. (6). Instead of having each tapper to tap a portion of each plot, or employing a complicated rotation of tappers in an attempt to even out their individual tapping errors, the following procedure offers a more simple solution. Within the limits of an experiment, comprising plots of sufficient size and number of treatments, it is possible to make each individual tapper responsible for a single block made up of one plot of each treatment—a single replicate that is, similar to the blocks already described.

Differences between tappers, causing differences in mean yields and errors, will be eliminated in the same operation as that designed to eliminate soil heterogeneity. The scheme is not rendered useless, if, on account of labour difficulties or sickness, the same team of tappers cannot be maintained throughout the experiment.

There are two further points of importance which come within the scope of these methods. In a large experiment it is not always possible to prepare by cultivation, to sow, or manure, to harvest, pluck or tap all the experiment on one day. In the meantime conditions may so change as to affect the results. In one instance the writer saw an experiment of the old type ruined at sowing because one portion was sown one day and the rest left overnight. In the meantime heavy rain destroyed the seed bed, and subsequent differences in treatments were masked by the overwhelming variation in the success of the establishment of the plant. Such a calamity would have been avoided if, when work had to cease, the interruption had been made coterminous with a block of treatments. The analysis of variance due to time of sowing would have saved the experiment. A typical tropical example would be the discordance in results in tapping rubber owing to weather conditions being unfavourable.

One persistent objection has been made against these methods. It has been urged that however good the supervision on the spot, a fool-proof method of arrangement is necessary. Criticism is levelled at the randomised arrangement on this score

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* This system has already been adopted by the Department of Agriculture in its paddy tests and is recommended in Bulletin No. 83 for Manurial Experiments with Rubber.—Ed. T.A.

and systematic arrangement is upheld. In the course of four years' experience with these methods, the writer has never had any difficulty at all of the nature suggested. In fact, a case can be made out in favour of the randomised arrangement being the more fool-proof.

Consider (a) a regularly ordered experiment and (b) a randomised one. If a mistake in the disposition of a certain treatment or variety is made and is not subsequently detected, both types of experiment are equally marred. If, however, the wrong allocation is made and noted, in case (a) any merit which appertained to an orderly arrangement is destroyed, and the experiment proportionally spoiled. In case (b) no such objection exists; the arrangement is still substantially a random one, since that particular grouping might, with all probability have been drawn out of the hat.

With regard to demonstrations of plots in the field, it is true that this is rendered more difficult by a random arrangement. To counterbalance this there is the knowledge that randomisation does away with any suggestion which may arise in the case of treatments ingeniously brought together for demonstration, that the experiment is definitely *ad hoc*. Critical appreciation will thereby be greatly enhanced.

The processes of calculation have purposely been excluded from this paper. They can best be understood by working over the actual examples which occur in the literature quoted. (1,2,8). The calculations have the great advantage that they are strictly arithmetical in scope, and do not need a knowledge of complicated mathematics.

References.

(1) Eden T. and Fisher R. A.—Journal of Agricultural Science XVII, 1927, 548.
(2) Fisher R. A.—Statistical Methods for Research Workers 1925.
(3) Fisher R. A.—J. Min. Agric. 1926, 503.
(4) Lord L.—Tropical Agriculturist LXIX, 1927.
(5) Lord L. and Wickremasekera G. V.—Idem.
(6) Lord L. and Abeyesundera L.—Dept of Agric. Ceylon Bulletin 82, 1927, 18.
(7) Rothamsted Experiment Station Report 1925-6.
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Mycological Notes (14).

Further Notes on *Rhizoctonia bataticola* (Taub.) Butler.

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SEVERAL new hosts of the root fungus *Rhizoctonia bataticola* are recorded in these notes. The most interesting of them are citrus seedlings, sunflowers and sweet potato tubers, the last being the substratum from which the fungus was described originally as *Sclerotium bataticola* by Taubenhaus in 1913. An interesting extension of the distribution of *Rhizoctonia* has been reported to the writer by Dr. Steinmann of the Tea Experiment Station, Buitenzorg. He has found the fungus on tea and *Albizzia* roots sent to him from Sumatra.

(1) Citrus seedlings. A large number of citrus seedlings, the majority of which had been successfully budded, died in a nursery in the Royal Botanic Gardens, Peradeniya. All were clear examples of *Rhizoctonia* root disease. Some were in beds and others in bamboo pots; all had been grown in what is regarded as good nursery soil. The Agricultural Chemist reports it to be a sandy loam with a large gravel and sand content and a fair amount of undecomposed organic residues. Its reaction is alkaline (pH value = 8·5). Its nitrogen and potash contents are fair, but it is poor in phosphoric acid. It is worthy of note that an analysis of an Experiment Station soil in which *Rhizoctonia* had attacked and killed avocado pear trees showed a similar deficiency of phosphoric acid (*Mycological Notes* (13)). Sclerotia of the fungus were numerous in the cortex and on the wood of the tap-roots of the diseased seedlings, and the loosened bark and dry clean wood of diseased roots were typical. In several cases, *Diplodia* attacked the dying seedlings. It had entered at or near the budding wound and had begun to work both downwards and upwards in the stems of the plants.

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(2) *Cupressus Lindleyi* Klot. (Knight's Cypress). Two examples of *Rhizoctonia* root disease of young plants of this cypress have been found in the grounds of the Farm School, Peradeniya. The dead trees were standing as in life but were browned and dry. All the roots were attacked in both cases. The bark was loose and the wood dry, hard and clean. Small sclerotia were very numerous in bark and cortex and on and in the wood of the roots. The present species is the third cypress to be attacked and killed by *Rhizoctonia* in Ceylon, the others being Lawson's (seedlings) and the Monterey Cypress.

(3) *Ipomoea Batatas* Lam. (Sweet Potato). A small consignment of sweet potato tubers was obtained from the Experiment Station, Peradeniya, for experimental purposes. The tubers were washed, dried in the sun and laid aside in the laboratory for a week. When they came to be examined before use, about twenty per cent. was found to be affected with and unbroken; *Rhizoctonia* sclerotia were numerous enough in the flesh of affected tubers to show the distinctive character of char-Taubenhaus' charcoal rot. The skins of the tubers were sound coal rot. As the fungus may cause a root and tuber disease of sweet potatos in the field as well as the storage rot of tubers known as charcoal rot, it is possible that the fungus gains entrance to the tubers through the roots of the plant. It is usual for tubers affected with charcoal rot to show no external lesions or softening or other sign of their abnormal internal condition.

(4) *Areca catechu* L. (Areca Palm). *Rhizoctonia* has been found in areca roots collected by the Plant Pests Inspector of the Central Division. The palm was reported to be a poor specimen, the leaves and fruiting branches of which were drooping and discoloured. Sclerotia occurred in the cortical tissue and on the central vascular strand of the roots. They measured about 180 microns in diameter when spherical and about 200 by 150 microns when longer than broad.

(5) *Crotalaria* sp. In the course of a paper entitled " Cover Crops and Green Manuring in Rubber Cultivation " which was given at the Agricultural Conference in May last and reproduced in *The Tropical Agriculturist* of the same month (70, p. 325), Mr. Mitchell of the Rubber Research Scheme mentioned that he had seen cases in which the mycelium of a fungus associated with root disease of rubber, *Fomes lignosus* for example, had spread from one rubber tree to another along the roots of cover crops, and he went on to say that he had frequently observed cases of attack of *Fomes lignosus* on woody cover crops such as *Crotalaria*. As examples of the spread of *Fomes*, he showed specimens of diseased *Crotalaria* roots and a young rubber tree on both of which was a certain amount of *Fomes* mycelium. At the writer's

request Mr. Mitchell kindly sent his rubber and *Crotalaria* specimens of root disease for examination. It was found that *Rhizoctonia* was present on the *Crotalaria* roots as well as *Fomes* and that on the rubber specimen *Rhizoctonia* and *Diplodia* were present in addition to *Fomes*. A careful examination of the rubber specimen showed that *Fomes* was more or less superficial and had not penetrated beyond the bark of the roots and that *Diplodia* extended from a collar-crack about ground level both upwards in the stem wood and downwards in the root wood, in each case for a few inches. As far as invasion of diseased tissues was concerned *Diplodia* had gone further, so to speak, than *Fomes*. A collar-crack is a frequent result of *Rhizoctonia* root disease, and it is possible that a complete picture of the various stages of disease of the young rubber plant would show the initial phase to be *Rhizoctonia* attack on the feeding roots and advance of the fungus into the larger roots, the second phase to be the entry of *Diplodia* by the collar-crack and the establishment of the fungus in the wood, and the third and last phase to consist of the appearance of *Fomes*. There was no *Diplodia* in the *Crotalaria* specimens and *Fomes* was again only superficial. Mr. Mitchell may have been correct in his statement that *Fomes* spreads among roots of cover crops and rubber, but it is doubtful if the specimens in question were killed by *Fomes* alone or by *Fomes* in the rôle of a primary causal agent and it is therefore questionable if the spread of *Fomes* mycelium from one root to another is a matter of prime importance.

Further, it is necessary to show that the white mycelium which is present in the circumstances described above is really what it is presumed to be, the mycelium of *Fomes lignosus*, and not that of, for example, *Polyporus zonalis*, a form which has been found in similar circumstances.

(6) *Theobroma Cacao* L. (Cacao). Several clear cases of *Rhizoctonia* root disease of cacao have been encountered recently. Lines or sclerotial plates and sclerotia were numerous in the smaller roots. The presence of root disease is shown above ground by a dieback of the branches, and an alga which is probably *Cephaleuros minimus* Karst. Occurs at times on the dying branches. Isolations from the junctions between diseased and apparently healthy tissue in dying twigs have given *Diplodia* and a species of *Fusarium*. The *Phomopsis* which is reported to be present in dying cacao branches in the West Indies has not been found in cacao in Ceylon.

(7) *Helianthus annuus* L. (Sunflower.) Wilted sunflower plants forwarded by the acting Plant Pest Inspector of the Southern Division showed large numbers of sclerotia in the bark and cortex of the stems at ground level. The roots were typically

hardened and had the usual loose bark. The development of sclerotia in quantity at the base of the stem recalls a similar condition in *Rhizoctonia* root disease of chillies, gingelly, dhal and other herbaceous and semi-woody plants.

A point of further interest is that the pycnidial or *Macrophomina Phaseoli* stage of the root *Rhizoctonia* which has been found in Ceylon in nature only on beans occurred among the masses of sclerotia on the sunflower stems. The development of sclerotia and pycnidia on the same stem site has been reported on gingelly (*Sesamum indicum*) from Uganda and Burma. In the case of beans, again, sclerotia and pycnidia have occurred on different parts of the same plants and also on separate plants. The sunflower pycnidia have been proved by Mr. Haigh to be those of *Macrophomina Phaseoli*, the spores having given the sclerotial *Rhizoctonia* in culture.

Selected Articles.

Rice Culture in Italy.

WHAT need is there for Indians to know anything about rice culture in Italy or for that matter any other country seeing that India which ranks first in the area under rice (acreage 80,683,900 for the years 1920-24) is probably one of the largest rice growing countries in the world and practises the cultivation of the crop to perfection while Italy has only an insignificant area of 300,000 acres. Yet Italy has lessons to give us as can be gathered from an interesting description of the cultivation of rice by Mr. D. Ananda Rao, B.Sc., Deputy Director of Agriculture, Madras, in the pages of the *Modern Review*. Taking first the yield, acreage outturn for the area under rice in India for the year 1920-24 comes to 47,365,017 tons whereas in the case of Italy it is 491,968 tons which works out to 1,300 lb. and 3,670 respectively for the two countries, the acreage yield in Italy being more than double that of India. Our readers are already familiar with the broad facts having had an opportunity of reading a valuable contribution on cultural methods in Italy by Mr. Galletti, I.C.S.

The methods of culture in Italy are in many respects similar to those in India. Sowing and weeding are done by hands as here. Transplantation is also done by manual labour and the harvest is done by means of the sickle very similar to our own. There the similarity ends. The most striking difference which one would not notice between the two countries is the way that fields are laid out for irrigation purposes. With the exception of large fields carrying between them irrigation or drainage water, there are practically no intervening bunds and extents of 30 acres or more have no intervening bunds as we are familiar with in the rice tracts in this country. From the main irrigation channels small distributing channels are taken off about 6 yards apart through which water is quickly let into the rice plots thus preventing waste of water in its distribution to cultivators. It is important to notice that the quantity of water required to mature the rice crop having been previously worked out, only the quantity actually necessary is measured and given to cultivators and it is noteworthy that the distribution of water is left entirely in the hands of the cultivators themselves. There are associations of cultivators charged with the duty of distributing water to their members and these Associations exercise great economy and see to it that percolation and wastage are as far as possible prevented.

A very interesting point with regard to the irrigation of the rice fields in Italy, is that the flow is not constant. On two occasions during the growth of the crops the fields are dried. Twenty-five days after the sowing, water is drained for four or five days with the attendant beneficial effects of soil aeration and root penetration. After this, water continues to flow till after the last weeding. Withholding water at this stage may have the result of preventing too much vegetative growth apart from aerating the soil. Before water is let in again, artificial manures are applied after which irrigation is constant until a few days before harvest. Another outstanding feature of

Italian rice cultivation is the rotation of crops practised which claims to have increased the output of rice. Before the harvest of rice it is the practice to sow rape, clover and other pulses which when grown are fed to cattle in spring. This is then allowed to grow again and turned into the soil as green manure. Compare the similar practices in the deltaic tracts of Southern India for example, Kistna where Sunnhemp is grown after the harvest of rice but when cut is stacked along with rice straw to be fed with it. Considerable advance is noticeable in the employment of mechanical methods in the culitivation of rice and in taking it to the market as a finished product. It is usual in this country to sell rice in the market as paddy but the Indian cultivator puts it through the further process of hulling by machinery before it is sold and thus keep the byeproducts to himself for feeding his livestock and rice is straightaway sent to the market for sale or export. The importance which machinery plays both in the cultivation of rice and in taking it to the market cannot be overestimated and here we have to take a lesson from the Indian cultivator. Suitable and cheap mechanical appliances to supplement manual labour, the practice or rotation where possible and economy in the distribution of water—these are some of the lines where the Italian cultivator has made advance to his benefit. And we agree with Mr. Ananda Rao that our intelligent land-owners should turn their attention to the effecting of improvements wherever possible in the cultural methods obtaining in this country following the lead given by the Italian cultivators.—*Rural India,* Vol. II. No. 6. 1927.

A New Green Manure Plant.

Crotolaria Anagyroides.

MR. V. S. Habbu, B. Ag., Superintendent, Kumta Farm, N. Kanara, writes as follows in the "Poona Agricultural College Magazine":—

San hemp (*Crotolaria juncea*) is grown extensively in the Deccan and elsewhere as a crop for green manuring, as it has been found to be the cheapest method of adding organic matter to the land. It has been found that a crop of san hemp one acre weighs from 18,000 lb. (*vide* Bombay Bulletin No. 47). The cultivators who are now growing san hemp would certainly welcome a plant which is both leguminous and heavy yielding. On the Kumta Farm a large number of species of plants are being tried with a view to find out those which are quick growing which can yield large quantites of green matter and which can stand lopping. These are tree-growing and bush-growing species. *Crotolaria anagyroides* is one which has been introduced from Ceylon where it was reported to be doing excellently well. The trial on this farm during 1926 and 1927 have given very encouraging results which excel those of san hemp. This plant has not been tried in the Bombay Presidency as far as I am aware of. The results of the trial are given in the article so that it may attract the attention of the cultivators and others who are interested in the matter of green manures and further that they may give trial to it under conditions prevailing in different places side by side with *Crotolaria juncea.*

Crotolaria anagyroides was tried both under irrigation during hot weather and also as a *kharif* crop. The crop grown under irrigation has given exceedingly good results and these are dealt with in this. That sown at the commencement of rains has not been able to give satisfactory results. The plants do not seem to stand the heavy rains of Konkan in the initial stage of their growth, for, a crop which had grown up to 5 ft. in height before the rains commenced has stood a precipitation of 90 inches without showing the slightest change for worse. The indications of this year's trial are that if a crop is to be grown during the monsoon, the seeds should be sown about the end of July when the force of rains has calmed down. The plants from the sowing of July have reached 10 to 15 inches by the end of August.

Cultivation.

A full-grown plant covers a space of 4 ft. square. The seeds were dibbled at 2 by 1 ft. two seeds being dorpped in each hole. The seeds germinated within three days. The growth of the seedlings during the first month was at the rate of 3 inches per week and from the second month onwards, the progress was rapid being 12 to 15 inches per week. In three months the crop reached a height of 5 to 6 ft. with 3 to 4 branches. If the plants are tipped when they are 12 inches in height they produce a large number of branches. In three months *i.e.*, 15th March to 15th June, the crop reached a height of 8 ft. The crop was cut leaving ⅓rd portion standing and the green material obtained (calculated from one guntha) amounted to 4,000 lb. per acre. By August 15, the fresh growth reached 3 ft. in length and this cut back to ⅓rd its length, gave 8,000 lb. of green matter per acre. The plants are still vigorous and growing. The plants that were left unpruned reached

to a height of 12 ft. by August 15, *i.e.*, in 5 months' time. From the observations made on two croppings it has been found that two loppings can very easily be obtained.

Crotolaria juncea was grown side by side. Its growth during the first month was faster than *Crotolaria anagyroides*. But during the next two months, it was left much behind. The height of the former was to 2½ to 3 ft. whilst that of the latter was 5 to 6 ft. San hemp produced flowers at the age of 3½ months.

Thus it can be seen that *Crotolaria anagyroides* is a fast growing species giving more quantity of green matter per acre (*viz.* 40,000 lb. from the first cutting and a substantial quantity at the subsequent lopping if there is time to allow it to grow than *Crotolaria juncea*) giving 18,000 to 28,000 lb. It is hereby suggested that this new plant may be given a trial side by side with san hemp.

The green loppings have also high manurial value when applied to the land. They completely decomposed within four weeks. The results on rice as compared with F. Y. M. are as follows.

	Quantity applied.	Grain per acre.	Straw.
	lb.	lb.	lb.
F. Y. M.	4,000	2,300	3,000
Crotolaria anagyroides.	—	3,600	3,800

The Seed of *Crotalaria anagyroides* can be had from the Central Seed Depot, Peradeniya, Ceylon.—*The Malayan Tea and Rubber Journal*, Vol. XVII. No. 1, 1928.

Pastoral Research Problems.

GEO. L. SUTTON,
Director of Agriculture.

Live Stock Position.

AUSTRALIA is essentially a pastoral country, a land of great flocks and herds. In 1925—the latest date for which complete records are available—Australia carried on its farms and on its stations 2,250,361 horses, 13,279,785 cattle, 103,563,218 sheep, 1,128,374 pigs, and it has carried in other years as many as 2,527,149 horses in 1918, 14,441,309 cattle in 1921, 106,421,068 sheep in 1891, 1,169,365 pigs in 1917.

The position to-day is in striking contrast to the humble commencement, which was made at the birth of the Commonwealth, when Governor Philip brought with him in 1788, 7 horses, 6 cattle, 23 sheep, 12 pigs, and a few goats. No great stretch of imagination is necessary to realize that innumerable problems were encountered and difficulties overcome before the gap between then and now was bridged. This is emphasized by the fact that in 1790—two years after the infant settlement was established—Governor Philip reported that no country offered less assistance to the new settler than did this, and that there was no prospect of feeding the small community under his control—about 1,000 souls—with its agricultural (including pastoral (products. Fortunately, as the result of the development of these natural advantages for pastoral purposes, which this country was found later to possess, the position entirely changed, and not only was the community able to support itself, but in the year referred to, or 137 years later, it produced agricultural and pastoral products far in excess of its own requirements. The wealth produced in the Commonwealth amounted in that year to £ 454,106,000, and of this the flocks and herds were responsible for £ 162,423,000, a sum almost equal to that produced by the manufacturing and mining industries combined.

Naturally, there have always been pastoral problems in Australia. In the early days the very survival of the young colony depended on their solution. To-day the position is hardly less important, for because of the tremendous interests involved, problems connected with the welfare of our flocks and herds, whether carried on farms or stations, are of transcendent importance. In the past the problems which have been solved were solved mainly by the common sense, grit and perseverance of those concerned, but they were also aided in some instances by the research work and discoveries of the scientific worker. The position to-day is that many of the present-day problems—including some of the unsolved ones of the past—can only be solved by him.

Work Being Done.

The problems which are now being attacked or awaiting attack may be divided into four main groups, viz., those dealing with—(1) Animal nutrition; (2) animal diseases; (3) the suppression of pests; (4) stock breeding

or animal genetics. Already a scheme of research in connection with animal nutrition problems has been undertaken by the Council for Scientific and Industrial Research, and has been placed in charge of Professor T. Brailsford Robertson, of the University of Adelaide, who has been carrying out investigations in connection with one phase of this work for the past few years under the 'Animal Products Research Foundation.' In this field, which is of immense scope, Professor Brailsford Robertson proposes to examine comprehensively Australian pasture to determine their mineral deficiencies, and also their mineral excesses. Associated with this will be the reasearch work to be carried out at the Waite Institute in order to determine the mineral content of Australian fodder plants under natural and artificial conditions. This latter investigation is to be conducted on parallel lines to those carried out in South Africa, New Zealand, Canada, and Britain. Professor T. Brailsford Robertson suggests that there is a very definite iodine deficiency in the pastures of parts of Australia, and he, therefore, proposes to conduct an iodine survey of our pastures. The nitrogenous content of our natural pasture plants is also to be investigated by him so as to ascertain what plants, or group of plants, are best adapted to supplement the protein deficiences of other plants.

Closely allied with plant nutrition problems are investigations connected with poison plants. In this State work in this direction is being carried out by Mr. H. W. Bennetts, the veterinary pathologist of the Department of Agriculture and research with these plants on other lines is also being undertaken in New South Wales. There the investigations have been divided into three main lines—Chemical, Veterinary and Pharmacological. The first section is under the control of Professor Kenner, of the Sydney University, and is to be carried out by chemists on the staff of the Council for Scientific and Industrial Research. There will also be collaboration with the chemistry section of the Sydney Technological Museum. In the veterinary section the experimental work is being conducted at the New South Wales Veterinary Research Institute at Glenfield, whilst in the Pharmacological section the work is carried out under the control of Professor H.G. Chapman, of the University of Sydney.

The function of research in connection with animal disease is, as pointed out by Professior M. A. Woodruff, to minimise, and if possible, eradicate some of the comparatively few diseases found in the Commonwealth, for it is important to keep the stock healthy, as unhealthy stock cannot produce maximum quantities of meat, milk or wool, however well and properly they may be fed. Research work on a comprehensive scale in connection with animal diseases is already proceeding in various parts of the Commonwealth. At the Glenfield Veterinary Research Institute work in connection with the following matters is in progress: (1) Paralysis in pigs —a disease which occurs especially in young pigs when they are being topped off for the bacon factory, and is matter of great concern to the dairy industry. (2) Toxaemic plethora—a disease which causes high mortality in the best lambs, and of which the cause is quite unknown. (3) Sterility in cows—a matter of very serious concern to dairy farmers as well as to graziers.

At the Sydney University Veterinary Department research work is being conducted in connection with (1) Braxy-like disease; (2) Cheesy cysts (Caseous lumphadenitis) in sheep—a disease which is prevalent in Australia, and which is becoming of serious importance in connection with the export of frozen mutton; and (3) Stomach worms in sheep and other parasitological problems.

At the Melbourne University Veterinary Research Institute, investigations are in progress on bovine pleuro-pneumonia, bovine tuberculosis, and the Life History of the Beef Nodule Worm.

In Western Australia investigations are in progress on:—(1) Braxy-like disease—by Mr. W. H. Bennetts, in the Veterinary Laboratory at the Department of Agriculture; and (2) Kimberly Horse Disease—by Professor Ewart and Mr. D. Murnane in the north-west of Western Australia. In connection with this investigation, it is gratifying to learn from a preliminary report issued by Professor Ewart that the investigations connected with this problem are likely to be brought to a satisfactory conclusion at an early date.

Investigations connected with the control of eradication of pests with the object of reducing and preventing the extention of losses therefrom involve:—The continuation of blowfly investigations; the continuation of the investigations dealing with the eradication of prickly pear; the continuation of investigations dealing with the control of the buffalo fly; the better control of the rabbit pest; the control and eradication of noxious weeds; the control of red mite; and the control of lucerne flea.

As indicating the necessity for research in connection with the suppression of pests, it may be stated that in a bad year the estimated losses due to the blowfly pest amout to £ 4,000,000. The devastations of the red mite and the lucerne flea are such as to threaten the wholesale destructions of the leguminous plants in our pastures, and are, therefore, a matter of most serious concern. Investigations in connection with these two pests are being carried out by Mr. L. J. Newman in the field and in the entomological laboratory at the Department of Agriculture, and it is pleasing to record that satisfactory methods of controlling these pests in garden crops have already been found.

Research and the Australian Merino.

Though there are awaiting solution problems connected with the cross-breeding of cattle for the production of possibly hardier types for special areas, and with the cross-breeding of swine for the production of better types for export bacon, the problems of animal genetics, which are of the greatest importance, are those relating to the production of merino wool. Of any single section of pastoral production the sheep contributes most of the pastoral wealth of Australia. Last season Australian sheep produced, 2,610,000 bales of greasy and scoured wool, which, when calculated on a greasy wool basis, contained approximately 850,000,000 lb. which realized £ 58,072,500. The sheep is in consequence, a symbol of Australian prosperity, and any work connected with its improvement is obviously of special interest. Before suggesting any line of investigation in connection with sheep breeding a tribute must be paid to the stud masters of Australia, who have done so much to increase the wealth obtained from this source. Though both our climate and our pastures are eminently suitable for the growing of merino wool, it is the human element which directs operations which is, therefore, responsible for the production of sheep which can take advantage of these to the full. Our debt to the stud masters of Australia in consequence is exceedingly great. Because of their efforts the flock masters of the Commonwealth have been enabled to more than double the average production of their sheep in a period of about 60 years. In 1861—the earliest date for which I have been able to obtain details—the average production of greasy wool per sheep (including lambs) was 3·74 lb. per head. Forty years later, at the beginning of the present century, the average production has been raised to 7·06 lb., or nearly doubled, and in the season 1924-25 the improvement was such that the production per head was 7·69, or more than double that in 1861.

Skill of the Breeders.

As far as can be learnt, the great improvement in wool production, which has taken place, has been brought about by the skill of the breeders following traditional methods, combined with that intuition for recognizing and selecting good stock, which is characteristic of many of the British race, who have a liking for and interest themselves in such work. The traditional methods are based upon the principle that 'like begets like, with a continual tendency to variation.' The result has been the vast improvement of the original stock already referred to and the evolution of the "Australian Merino" of several distinct types which have been developed to meet the requirements of differing conditions of climate and feed. The improvement is still going on, but because of the great success already achieved, further improvement is more difficult of attainment. To aid in the performance of this more difficult task there is, however, now available the information resulting from the persistent study of the laws of inheritance by eminent workers during the present century.

The great aim of the stud sheep breeder is to secure animals of uniform excellence and with ability to transmit their desirable qualities to their progeny. This is also the great difficulty. The greatest improvement which has been achieved in this connection is believed to have been secured largely as the result of mass selection within inbred flocks. In view of the information now available regarding the laws of inheritance it is possible that further advancement lies in initial selection within inbred families in order to secure parents which are genetically pure (homozygous) with regard to particular desirable characteristics) the initial selection necessary to secure these to be followed by the subsequent crossing of related families of the same homozygous type. Before the genetically pure individuals of the type desired can be selected with certainty by the stud master, research is essential to determine the extent of environmental variation so as to ascertain the factors which are purely hereditary, for it is well known that the environment—of which feed and climate are part—also modifies the quality and the quantity of wool produced. With this information available, the breeder will be enabled to determine which of his animals are genetically pure and which in consequence can be relied upon to transmit the factors which they possess to their progeny. The importance of ensuring that the parents are pure regarding the desirable factors is illustrated by what has been discovered in connection with the inheritance of wool colour in sheep. It has been found that the production of white or black wool is due to the presence of inherited factors, viz., the colours black and white, of which white is dominant over black. For a black wooled sheep to appear it is necessary for the animal to be pure for the black factor. On the other hand a sheep carrying white wool may be either pure for the white factor, or it may also carry a latent factor for black. In consequence if but one genetically impure heterozygous white sheep ram or ewe, carrying the factor for black in its germ cells, be introduced into a pure white flock, it is possible by selection within that flock to develop a pure black flock from it. Research is also necessary to ascertain the extent to which blending and linking of the factors which are hereditary take place.

It is important to stress the necessity for research in the direction indicated for remarkably little is on record regarding the factors which are inherited and connected with the production of wool and its quality.

Laws of Inheritance.

The laws that govern inheritance have been found to be much the same in the plant as in the animal world, and as there are certain points of similarity between the process of reproduction, and in the methods adopted for the prevention of deterioration in maize and in animals, it is of interest to refer to the results of the work of Professor G. R. Shull in connection with the genetics of the maize plant. The maize plant, though hermaphroditous, is usually and preferably fertilized by the pollen from another plant. To obtain seed for the succeeding crop the ears are "culled," *i.e.*, only the best specimens are retained, as with sheep in the breeding flock. It was found that seed from the choicest ears could not be relied upon to reproduce their excellence either as regards their quality or yield. In order to study the cause of this Professor Shull commenced his research work. He found the seed so culled was not genetically pure (homozygous). The strains were not pure, and consequently did not breed true to type. Because the seed bearing plants were pollinated from other plants of the same so-called variety of strain, and neither was genetically pure, though of the same type, the effect was similar, but in a lesser degree to that of crossing, and the lack of uniformity was accountd for. The fact that a cross-bred plant or animal may be as fine or even finer looking than a pure bred and that it is not prepotent because it does not carry its factors in the duplex condition in its green cells was emphasized. Professor Shull set to work to correct this lack of uniformity, and to secure pure strains or homozygous plants by inbreeding. He inbred and inbred until the resulting plants and cons were nothing but low yielding runts, and at one bound the resulting seed showed in addition to uniformity, remarkable vigour, and produced a crop of 77 bushels to the acre, four times the average yield of their inbred runty parents. As the resust of mating some of the families which "nicked" well the yield of 98 bushels per acre was obtained, or 20 per cent. greater than the original parents which have never been inbred at all, so that both prolificacy and uniformity as well as conformity has been secured.

Experiments with Wool.

At the Animal Breeding Research Department, University of Edinburgh, research has been conducted regarding the inheritance of various types of wool. Much useful information was obtained in a short time, not the least of which was that the presence of both "kemp" and "black hair" is inherited and amenable to selection. In view of the most important part which wool plays in connection with the production of our national wealth, a special plea is made that there be provided somewhere in Australia, facilities to conduct similar work by similar means (research) in connection with our great merino flocks. It is believed that research in connection with animal genetics will indicate the speediest and readiest means by which the average production of our sheep can be permanently increased.

Research in connection with animal genetics is team work. It will mean at least a dual and possibly a triple alliance. The knowledge and skill in management only acquired by practical experience with, and close observation of sheep or other animals and their peculiarities, is as essential as academic training. The active and close co-operation of the practical pastoralist with the trained scientific worker in applied agriculture is therefore, necessary and they in their turn may need to call in, as a consultant, the worker in pure genetics.

Some realisation of the great value which research is likely to be to the pastoral industry on farm and station may be obtained from the successful results already obtained in connection with animal diseases. I am indebted

to Mr. H. W. Bennetts, verterinary pathologist to the Department of Agriculture, for the following instances :—

Beneficent results due to diagnosis of contagious diseases and sonsequent segregation or disposal of carriers of infection, by means of laboratory and other methods, *e.g.*, (1) diagnosis of tuberculosis by tuberculin test; (2) diagnosis of carriers of contagious bovine abortion by means of agglutination test (a "blood test").

The prevention of disease by means of biological products of disease—*e.g.*, (1) Anthrax—sheep, cattle, and horse may be immunised by means of vaccines and run on anthrax infected pastures without loss. (2) Tick fever in cattle—cattle made tolerant of infection by previous treatment with infective blood. (Bulls have been so treated prior to shipment to the North-West.) (3) Swine fever, rinderpest, blackleg, etc.

The prevention of parasitic infestation as the result of elucidation of life histories of animal parasites, and attacking any weak links in the chain, *e.g.*, (a) by drainage of running susceptible animals on high dry parts of pastures, and (b) by using "trough" water for stomach worms and lung worms.

By treatment—either with drugs or biological products—*e.g.*, (1) sheep scab (mange) has been eradicated from Australia by means of dipping, (2) tick and lice control by dipping, (3) trypanosomiasis—various conditions due to blood parasites as "Surra" can be treated with complex drugs, such as "Bayer 205." (4) stomach worm infestations in sheep and cattle can be more or less satisfactorily treated with copper sulphate given as a drench. With periodical treatments sheep particularly can be reared on heavily infested country which otherwise would not be possible economically.

Fruits of Research.

Sometimes the fruits of research are gathered quickly as was the case with a recent investigation carried out by Professor Ewart in connection with the cause of the losses of the cattle on a section of an important stock route between Wycliffe Wells and Taylor Crossing in the Northern Territory, and known as the poison zone. Thousands of cattle pass along this route every year, and in 1923 an average of 20 animals out of every 100 died of some kind of poisoning on that road. It was arranged that Professor A. J. Ewart of the Melbourne University, should investigate the cause of the trouble. Almost at once Professor Ewart placed two plants under suspicion—one a sage bush (*Isotropis atrapurpurea*), and the other an indigo plant (*Indigofera boviperda*). The suspicions proved well founded, and in 1925 steps were taken to clear a strip of this poison some 150 yards wide and about 40 miles long. This was done with the aid of native labour at a cost £ 150. In 1926 a mob of 3,000 cattle passed through this one time poison zone without a single casualty.

At other times results are obtained only with great difficulty, and after prolonged search, as appears likely to be the case in connection with the Buffalo Fly investigations. Sometimes results are not obtained in the direction desired. A research worker is not like a manufacturer; he cannot begin on a problem and say that he will finish it, or even reach a certain stage in a given time. He has to apply all the knowledge he possesses and the best technique of which he is capable, and then carry on in the hope that he will succeed. To encourage him to look forward with hope he can look back upon the success other workers have achieved in the same or in a similar domain. Whilst this is being done those who are concerned in his work must be asked to be patient.—*Journal of the Department of Agriculture, Western Australia, Vol. 4. No. 4. 1927.*

Tobacco.

THE second hybrid generation of the crosses between Pusa Type 28 and the imported tobaccos Adcock and White Burley was grown and studied. About 8,000 plants were raised and numerous selections were made from this population. The selections were made chiefly with the object of obtaining a vigorous hardy plant which could retain the colour and the burning and smoking qualities of the imported tobaccos. Over the whole population, records were taken of the flowering date, leaf area, height and number of leaves per plant.

Trials of the imported American tobaccos, Adcock and Burley, were continued during the year under review with special reference to their yielding power and smoking qualities. The experience in previous seasons had suggested that these tobaccos did better in Bihar if sown and transplanted considerably earlier than is usual in the local practice. In the past season sowing was carried out about the end of July and transplanting about the end of August, or first week of September, and very good crops of both Adcock and Burley were raised. The Burley yielded at the rate of 1,300 lb. of dry leaf per acre and was air-cured on racks. The leaf obtained was of excellent colour and quality. This tobacco is a pipe tobacco and there seems to be no difficulty in Bihar in curing the leaf to the rich mahogany colour which is characteristic of the best grades of this tobacco. The Adcock tobacco yielded at the rate of 900 lb. of dry leaf per acre and the problem of curing this leaf is by no means as simple as in the case of the Burley.

The experiments of the previous season had suggested that the uncertain climate of Bihar during the curing season rendered it impossible to produce bright leaf from the Adcock tobacco by air-curing on racks. At the same time a small experiment in flue-curing had shown that there might be considerable possibilities in this method for the successful production of high grade bright leaf in Bihar. With the object of making a thorough trial of flue-curing, a tobacco barn was constructed in the Botanical Station on the lines of those used in the tobacco-growing districts of America. Such a barn is practically a small closed room with a furnace built into one wall and an iron flue-pipe running round the room and passing into a chimney. The temperature of the room is regulated by the amount of fuel consumed in the furnace and also by the opening and closing of certain ventilators cut in the wall. The principles governing the use of such a barn are broadly that the tobacco must be harvested at the right stage of maturity and must consist of uniform leaf and that the correct moment in the curing process must be selected for raising the temperature of the barn. The early sowing of the Pusa tobacco resulted in the crop being ripe in January and several curings were carried out in the barn with results which were very satisfactory as regards the colour of the cured leaf, a considerable proportion of which was of a bright lemon yellow colour. The burning and smoking qualities of the leaf are now under test and the economics of the process are being studied. The production of bright tobacco in Bihar as a commercial success is a matter of the relation between the yield per acre, the cost of curing and price of the leaf. The experiments carried out in the Botanical Section suggest that the yield per acre will be satisfactory and the work of next season should give some insight into the other two factors.—Extract from the Report of the Imperial Economic Botanist of the Agricultural Research Institute, Pusa.—*Scientific Reports of the Agricultural Research Institute, Pusa,* 1926-27.

Pruning Backward Trees.

THE effect of pruning crowns of backward Heveas in combination with manuring and similar measure of estate improvements was one of the subjects treated at a meeting of the Soekaboemi and Rubber Planters Association, by the chairman. He had experimented on a backward, in fact a practically abandoned area, covering about five bouws where about the middle of 1924 the crowns of the Heveas were cut back until only the stems and parts of the main branches were left. A number of the trees had dead crowns before the experiment was begun, and the entire block had a very sorry appearance, but results of the drastic pruning was amazing. To be sure 10 per cent. of the trees were lost due to the experiment, but the remaining trees recovered rapidly and after only one year showed entirely new, full and healthy crowns. In other parts of East Java, the test for some reason or other failed, but on this particular area, which, after the pruning, was manured in May, 1925, and again in July, 1926, the trees which had been practically abandoned for six years, made so good a recovery that they could be successfully tapped again in October, 1926, and now give excellent yields. The costs of pruning and later tarring the wounds came to a total of from five to eight guilders per bouw (bouw = about 1·75 acres).

Dr. Bobilioff, who was present at the meeting, commenting on the experiment, agreed that excellent results could undoubtedly be obtained by the methods described in similar cases. Up to the present the point has not been studied scientifically, but he felt sure that the method would be more widely adopted in the future. It is a pathological question, and it was only through more practical tests that a definite conclusion on the subject could be reached.—*India Rubber World. Vol. 77. No. 4. 1928.*

Acclimatisation of Plants.

J. COMBER,

Nymans Gardens, Handcross, Haywards Heath.

ALTHOUGH the acclimatisation of plants is a subject of great importance to gardeners, science can give us little guidance as to the temperature necessary to maintain life in any plant new to cultivation. Appearances are deceptive ; no one by looking at a plant, not even by a close botanical examination, can say whether it will survive 20° or 30° of frost. What is it that enables a plant to withstand severe cold. It would seem that the plant gradually adapts itself to low temperatures—but how ? As gardeners, I am afraid that we have been more concerned in simply finding out this quality than in searching for the reason of it.

A notable attempt has been made during the last thirty years to test the hardiness of the many plants introduced of late and others which had hitherto been grown only under glass. This has been an easier task than formerly because propagation is now better understood and more practised in private gardens, and surplus plants are available for experimental treatment. Since the war, great strides have been made and many plants once regarded as tender are now developing into large specimens in the open garden. So large and well furnished have many of these become that it will require a very severe frost or a recurrence of such frosts to seriously affect them.

There are many who argue that such a winter as that of 1895-1896 would effectually clear our gardens of plants which, admittedy unique and beautiful, are regarded as unreliable. Granted that a hard winter would cause severe losses, the fact remains that such frosts occur only at extremely long intervals, and that many of these plants, *Abutilon vitifolium* for instance, grow and come to maturity quickly, repaying in a short time any care bestowed upon them.

Some old green house plants (*Trachelospermum jasminioides* and *Abutilon vexillarium* may be cited as examples) were rarely presentable under glass, but may now be seen flourishing on many outside walls in the southern countries. Again there are many plants, to which even in large houses, it is difficult to allot sufficient space.

Camellias, for instance, are nearly always cramped for room, and, as specimens, are not comparable to those grown under favourable conditions outside. This phase of gardening then, although it carries a certain amount of risk and some drawbacks, holds out a rich reward to those, who, making stepping stones of their failures, go on undaunted.

The last decade has been a favourable one ; there has been no winter to equal that of 1916-1917 in severity ; the low temperature and bitter east winds experienced for so many weeks at that time, severely tested plants from Australia, New Zealand, South America and China. Owing to the war, and consequent shortage of labour, it was impossible to afford them much protection, or to do more than record the killed and injured under headings that often needed further qualification.

Tabulated records are often most contradictory. Thus in a report carefully prepared by Mr. E. A. Bowles, and issued by the Royal Horticultural Society, one finds that plants of *Abutilon vexillarium*, grown against a wall at Monreith, were killed and cut down to the ground level respectively, while others in the open were uninjured. In most other gardens a wall proved a safeguard. Gaya Lyalli, now registered as fairly hardy, was cut to the ground at Guildford, and badly injured at Exeter, whereas at Aldenham, Enfield and Kew, it escaped injury. The Chinese plants, principally from the north-west, introduced by the French missionaries, but more especially by Dr. A. Henry and Mr. E. H. Wilson, withstood the test remarkably well. This fact, no doubt, led to further exploitation of that region and increased care in collecting seeds under conditions that would secure the hardiness of the plants raised.

In the late Andean expedition, seeds of some well-known plants were collected from new and cooler districts with that object in view. My thirty years' experience in acclimatising plants in these gardens leads me to attach particular importance to this point. In many cases, notably with *Eucalyptus cordata*, now thirty or forty feet in height, success was only attained after five or six plants had failed. A similar experience might be recorded of Tea plants, until a dwarf, shrubby kind was found, probably imported from a high altitude, which has not only lived but flourished.

Site, exposure, drainage, soil and the condition of the plant, all vary its ability to withstand frost. Even in favoured countries, sites a few hundred feet above the average level would appear advantageous; the cold air sinks and the higher ground escapes the destructive frosts that are the bane of low, sheltered valleys.

Those parts of Great Britain which are most favourable to the growth of tender plants are usually near the sea; undoubtedly the climate is milder; it is, however, open to question whether this alone is the reason why so many plants succeed in such localities. Exposure to the sun and air, and the increase of light by reflection from the sea, all play an important part in maturing the woody stems of many half-hardy plants. This is well known at Highdown, where Major Sterne contends so successfully with difficulties of subsoil, etc. The value of exposure for numbers of plants, especially those from New Zealand, is exemplified at Wakehurst Place, where species, usually over sheltered, are growing in beds extended into the open park. The sturdy, short-jointed growth obtained is not only more floriferous, but hardier. At Nymans, the gardens are about 450 feet above sea level, and, but for trees, are exposed to wind from every quarter except the north-west, and though sometimes a cause of loss, we regard the site as beneficial, on the whole.

All gardeners—and many garden owners—know how difficult it becomes, in an already crowded garden, to choose suitable stations for plants. So long as new ground is being taken in little trouble is experienced. There comes a time, however, when extension is no longer possible, yet new plants are continually arriving, and places must be provided for them. It is then, that sun-loving plants are often placed between taller specimens, and are cut off from air and sun light, except for a short period of the day. Plants so placed may in the event of destruction by frost, be recorded as killed or injured but they provide no evidence of the hardiness of a species. The differences which make for success or failure are very slight. A position on a dry bank where a plant grows slowly and matures thoroughly will sometimes prove successful for plants that have hitherto failed completely.

Shelter from the north and east may take many forms, such as hills, woods, belts of trees, hedges, walls and evergreen shrubs. The piercing winds from those points during prolonged frosts are much to be dreaded; they dry out the sap from evergreens when there is little chance of its being replaced.

It seems almost a paradox to state that the lower half of an exposed north wall is a sheltered place, but it is so in practice, especially if there is protection on the east; probably air currents form a curve before reaching the wall in order to surmount it.

Soil greatly influences the hardiness or otherwise of plants; in rich soils the growth is so gross that it is with difficulty ripened before the advent of winter. Very dry soils, too, have a distinct disadvantage in that growth is often checked by drought and commences again in late summer or autumn, only to be destroyed by frost. A soil of medium quality, containing a fair quantity of grit or stone would appear ideal.

The condition of the plant is of great importance; the need for inherited hardiness has already been stressed, but the individual plant should also have a good start in life. It should not be subjected to undue heat in propagation, but grown hardily from the first and acclimatised so much as possible. Early planting, say, in March or April, will allow it time to be established before winter. To meet competition, the nurseryman is often obliged to grow plants thickly together and sell them when they are rather small and weak. If dwarf enough they may be grown on in frames. Taller examples are more difficult to deal with. Too often they are housed in late fruit houses, which need to be kept warmer just when the plants should be receiving free ventilation.

The question of protection has caused much controversy and gardeners are about equally divided concerning its advantages and disadvantages. There are times when protection is very useful, especially to young plants, and it is astonishing what a small amount is sufficient sometimes to save life. This was forcibly brought to my notice many years ago, when mourning a plant of Rhododendron *indicum*, apparently totally destroyed. A musa leaf had been dropped on a part of the plant, pressing it to the ground, and the portion thus protected escaped injury.

Those who should be experienced in this matter tell us to use dry covering only, and that if it is wet it is worse than useless. There is little doubt that a dry covering is most effectual; but frosts usually last for a few days and sometimes weeks. If there is the slightest sleet or thaw, the coverings will become wet, and in how many large gardens is it possible to remove and dry them?

In the years before the war we protected a considerable number of large plants, and the operation rarely occupied less than three or four days of steady work. The method which proved to be most effectual was to cover the roots heavily with leaves or Bracken, and secure mats or evergreen boughs at a distance of about eighteen inches from the plant, either by making a wigwam over it or, in the case of all plants, by leaning poles against the walls and covering them. In every case a space between plant and covering should always be secured. In the future it may be possible to decide by examination the hardiness of a plant, and not only to foretell frost, but also its severity and duration sometime beforehand; when that day arrives gardening will have advanced one step nearer to becoming an exact science. *The Gardeners' Chronicle*, No. 2138. Vol. LXXXII. 1927.

The Movement of Nitrates in the Soil and Sub-soil.

THE study of this subject has been continued in connection with three areas under different cultural conditions, *viz.*, pasture, fallow and unirrigated cropped land, and the investigation was concluded in October last. Three hundred and twenty-four samples of soil and sub-soil were collected during the period July to October and examined for their moisture and nitrate contents. The results generally confirm the conclusions drawin in previous years and point to the conclusion that—(1) nitrification becomes very active when the rains begin and early reaches a maximum, (2) with the subsequent heavy later rains very considerable quantities of nitrates are washed into the sub-soil and ultimately lost, (3) very little of the large quantity of nitrate produced during the early rains is utilized by the crops grown during the period, (4) the nitrate produced during the latter portion of the monsoon is, however, not lost and is utilized by the cold weather crops, and (5) there is no appreciable upward movement of these sub-soil nitrates.

The investigation has now been stopped and the results obtained are in process of tabulation and preparation for publication.—Extract from the Report of the Imperial Agricultural Chemist of the Agricultural Research Institute, Pusa.—*Scientific Reports of the Agricultural Research Institute, Pusa,* 1926-27.

Influence of Fermentation on the Nitrification of Organic Manures.

The nitrification of the organic nitrogen of mustard cake had been found to proceed more rapidly after the cake had been fermented with soil and charcoal than when fresh cake was used. Experiments were therefore begun to see if similar composting had any influence on the nitrification of the nitrogen in *mahua* (*Passia latifolia*) cake. The nitrification was examined in black cotton and Sihar soils from the Central Provinces as well as in Pusa soil. In every soil most nitrate was recovered from the composts of cake, soil and charcoal, and in these composts there was also most ammoniacal nitrogen. The composts were used for manuring small plots of oats, and the yields of oats were highest in the plots manured with the cake fermented with soil and charcoal. Composts containing sulphur were too expensive to be profitable.

The cake-charcoal-soil compost is made by mixing 100 parts of cake, 25 of soil and 5 of charcoal, moistening with 65 parts of water and inoculating with a little watery extract of fresh cow-dung. The heap is left alone except for the addition of water to make up losses of moisture, and is ready for application to the land after twelve weeks' fermentation.—Extract from the Report of the Imperial Agricultural Bacteriologist of the Agricultural Research Institute, Pusa.—*Scientific Reports of the Agricultural Research Institute, Pusa,* 1926-27.

Ustulina Zonata, (Lev.) Sacc.
A Warning Note.

F. W. SOUTH, M.A.,

Chief Field Officer.

ATTENTION is invited to the prevalence of the Dry Rot fungus, *Ustulina zonata,* on the stems and main branches of rubber trees on several of the older rubber estates, especially in the coastal districts of Selangor. The attack usually occurs on a large branch, or on the main fork, at a spot where a wounded surface is present owing either to the careless pruning of a lateral branch, or to damage caused by wind, or by an accident such as the felling of another tree when thinning out is in progress. The fungus is carried to the wounded surface by wind or by boring insects, especially beetles, which can convey spores of the fungus, or small pieces of infected material, on their bodies.

The prevalence of this disease on old rubber tree stems and branches affords a practical illustration of the soundness of the advice, consistently given by the Department of Agriculture, as to the importance of burning felled trees and all large pruned branches on estates with the greatest possible despatch, and as to the need to exercise care in pruning. If the large portions of rubber trees are left lying on the ground, or if dead stumps are not promptly removed after thinning out, the fungus will almost invariably attack them and in due course produce very large numbers of its spores on their surfaces, so providing a liberal source of infection.

Even though such sources of infection are carefully destroyed, it must be remembered that the fungus is fairly generally prevalent, so that it is always advisable to protect wounded surfaces and to make sure that any necessary pruning is properly done.

When removing a large branch, the first cut should always be made on its underside close to the trunk, or larger branch, from which it is being removed and should penetrate to about one-third of its thickness. The branch should then be cut through from the upper side at a point a few inches further out than the cut on the under side.

As a heavy branch always falls before it is cut completely through, this method prevents it from tearing a strip of bark and wood out of the trunk or larger branch to which it was attached. No hat pegs should be left, but all branches, or stubs of large branches cut off in the manner described above, should be removed at their junction with another branch, or with the main trunk, and the wounded surface should be smoothed with a sharp instrument and be thoroughly tarred at once. One or two further dressings of tar should be applied at intervals of about three weeks. Wounds caused by wind or accidents should be smoothed off with a sharp instrument and care should be taken to leave no hollows in which water can collect. Such wounds should also be dressed two or three times with tar.

If attention is given to these preventative measures the losses caused by *Ustulina zonata* and other fungi capable of attacking rubber trees through wounded surfaces can be much reduced. —*The Malayan Agricultural Journal.* Vol. XV. No. 12.

Agriculturists and Education.*

PRINCIPAL S. C. SHAHANI.

TEACHERS in the rural areas should preferably be drawn from the agricultural classes, for they will have lived in agricultural atmospheres and their agricultural training will have been on that account better realized.

The attendances at most of the existing institutions are not so numerous as one would expect in present circumstances. The reasons are in my opinion these—(a) the students are having jobs in different services as their goal, and get disappointed if at the end of the careers they do not secure suitable jobs; (b) the institutions being insufficient, if an only College, like the Agricultural College in Poona, in the Bombay Presidency, happens to be distantly situated to some parts of the Presidency, *e.g.*, Sind, the attendance here becomes thinner still on that account; (c) the training in the existing institutions is not practical in proportion to its scientific nature, (d) the people being comparatively poor, the number of scholarships and free studentships are not so many as they should be, and (e) agricultural education is not properly graded. If, at present, there are colleges there are no schools—secondary or primary and *vice versa*.

Industrialized Agriculture.

My views on—(a) nature study; are natural manifestation—earth, sky, light, grasses, grains, fruits, flowers, birds and animals, should be made generally intelligible to all students, and their powers of observation and interpretation exercised and sharpened; on (b) school plots; that the plots should be numerous, representative, and worked as far as possible by students only under the guidance of teachers, and on (c) School farms; that they should be devoted to experiments with the staple products of the localities, and to small dairies and their products.

The careers of the majority of students who have studied agriculture are—Agricultural Service, (b) Forest Service, (c) Revenue Service and (d) Management of Cultivation or both of one's own or other lands. In Sind (d) is rare. As the agriculture of Sind develops, especially after the Sukkur Barrage is completed, (d) can absorb a progressively large number of our agriculturally trained men. As it is, pathetic sights such as that presented here by a Bachelor of Agriculture, selling shoes and boots as a shop-assistant will not be uncommon.

There are to my knowledge very few movements for improving the technical knowledge of those who have studied agriculture. Industrial chemistry or other sciences can be included in the agricultural, arts and science curricula. Agriculture can be industrialized by the teaching of *e.v.*, the process of making molasses or pressing oil-seeds, or ginning and pressing, or milling grains, and cultivation can be industrialized by the teaching of the methods of using tractors or other mechanical devices.

* Part of Statement furnished to the Royal Commission on Agriculture.

Popularizing Adult Education.

Adult education in rural tracts can be popularized by (a) making it free, and (b) demonstrating that agriculture can be made a paying proposition. As in America and Germany movies and their graphic representation of the success of certain agricultural methods may, I think, be employed with effect.

Free education and demonstration in rural areas can be done best for the present by the Agricultural Departments, which should be better financed by their Local Governments, with earmarked revenue from, if need be, certain special educational cesses levied from the comparatively larger land-holders.

The measures which in my view have been successful in influencing and improving the practice of cultivators are the following :—

The existence in the midst of cultivators of a superior cultivator whose practice of cultivation is really an improvement in one or more aspects upon the general practice. In Sind nothing has done so much good as the devotion of the Punjabi cultivator to the method of breaking several times the land that he puts under cultivation and thus aerating it. The necessity of manures has thus been a great deal reduced, and the economical use of water inculcated.

The selection of seed and then its distribution done by the Agricultural Department on their seed-farms of thorough ginning factories or by imports.

The demonstration done on the cultivator's own lands.

The bulletins issued by the Agricultural Department, to a certain extent, whenever they are translated into vernaculars, which are known to a few of the cultivators.

The exhibitions and shows that are occasionally organized by the Agricultural Departments.

Rural Insolvency.

The measures in my opinion necessary for lightening the agriculturist's burden of debt are improvement of water-supply, better intellectual, moral and spiritual agricultural training, better laws calling for exact accounts from the money-lender but not furthering withholdings of legitimate debts, and short-term and long-term credit on easy terms.

Special measures to deal with rural insolvency, to enforce the application of the Usurious Loans Act, or to facilitate the redemption of mortgages should be so designed as not to shake cultivators' credit or to undo the good relations subsisting between them and others of the society to which they belong, which will, however, be very difficult of achievement. Special protective measures should, therefore, on the whole be avoided.

Measures taken to restrict or control the credit of cultivators such as limiting the right of mortgage and sale, like Act III, providing for the occupancy of lands on the Jamrao Canal in Sind on restricted tenure and not on capitalists' terms, operate, in my opinion, against the occupants by reducing their credit, and against the society by letting those hold land who were least fitted to cultivate it. But non-terminable mortgages may be ended to give the mortgagor a chance to reclaim himself. As far as possible hereditary cultivators should be enabled to remain as cultivators.

The means for reducing the loss in agricultural efficiency attendant upon the excessive sub-division of holdings in my opinion are— (i) co-operative farming, (ii) prevention of excessive sub-division by Government fixing the standard unit of holdings, and (iii) by extremely small occupants finding it necessary to sell their holdings to their neighbours who by joining the newly

acquired holdings to those already held by them, make their holdings larger and therefore capable of being profitably cultivated. (i) is the best means; (ii) is the next best means; and (iii) next to (ii). Government agency may, however, be considerably refined by its seeking co-operation with village communities.

Co-operation in Farming.

The obstacles in the way of consolidation by co-operative farming will in my opinion be overcome by education of cultivators and by their actually experiencing benefits of co-operation in farming; those in the way of consolidation through Government agency may be overcome by Government reducing cultivator's dislike for interference by seeking co-operation with village communities, and those in the way of consolidation by natural sales, such as prestige attaching agricultural sales, such as prestige atttaching to agricultural ownership, may be overcome by (a) development by education of cultivators' disposition to mind the business side of agriculture, and by (b) provision of industrial occupation for holders of extremely small holding when they will be ready to forgo considerations of prestige for the sake of earning a livelihood.

(c) Disputes *re* fragmentation of holdings should be kept out of the courts as far as possible, and referred to Panchayats and communities. Present litigation has become very costly and judicial decisions have in addition a tendency to be dilatory. But certain laws will become necessary to deal with interests of minors, widows with life interest, legally incapable persons, etc., as affected by the newer measures necessitated by the inconveniences from fragmentation. Only that their execution should be done as far as possible through Panchayats and communities.—*The Mysore Economic Journal,* Vol. XIII, No. 12, 1927.

Co-operative Marketing.*

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WITH the Royal Commission on Agriculture in session interest has been naturally aroused in various aspects of agriculture, but unfortunately the problem of marketing has not received the attention it deserves. So long as the cultivator is in the present unhappy position of asking "What is the price?" at the time of buying as well as of selling, so long as he has to effect his purchases dear and his sales cheap, there can be no appreciable improvement even if his output is better in quality and bigger in quantity. Of the purchase and sale again, the latter is in the worse position, specially in India.

Difficulties of Marketing in General.

As a matter of fact, the marketing of agricultural goods is a very difficult affair all the world over. It is much more difficult than the marketing of manufactured products. For one thing, agriculture is dependent on the uncertainties of nature in the matter of temperature and rainfall. For another, even a promising harvest may be suddenly spoilt by the depredations of tiny pests like boll-weevil, black rust or phylloxera. Apart from these, one cannot regulate production in accordance with demand even by international agreements. The Rubber Restriction Scheme of Britain, the Coffee Valorisation Scheme of Brazil, the Cotton Restriction Scheme of the U.S.A., etc. have been found to be much more difficult in operation than, say, the International Steel Combine. Seasonal production, bulky and perishable nature of the goods, etc., also raise complex issues absent in the case of manufacturing industries.

Special Difficulties in India.

(1) Small Holdings.

Over and above these, there are special difficulties in India. It is not possible to generalise for such a big country with its different parts in such widely dissimilar economic conditions but the following points may be noted. India is a land of small holdings and the produce of each unit has to be marketed separately. If goods are not bulked, adoption of up-to-date marketing methods is clearly impossible. Expert grading and packing, efficiency in the matter of transport finance, insurance and warehousing, in fact, any of the indispensable features of modern commerce cannot even be thought of. Yet it should not be forgotten that archaic methods of marketing detract considerably from the value of modern farming. Bigger and better crops by themselves will not improve matters unless they fetch better prices. As has been pointed out by a competent authority, the fertility of the soil is of much less importance than the fertility of the brain controlling the soil and its produce. "The former kind of fertility is, and may remain, a capacity only: the latter is an energy."

* A paper read before the eleventh session of the Indian Economic Conference held at Lucknow in January, 1928.

(2) Costly Financing.

One result of small holdings is that financing cannot be properly organised and has to be effected locally, making it at once costly and wasteful. In the course of his evidence before the Agricultural Commission, Dr. Mann stated that in Khandesh the Cotton-growers were not dependent on money-lenders. If that is so, that is probably the only instance of financial independence of cultivators. In some outlying areas, things are very bad indeed. It has been reported by an experienced Bengal official that cardamom sold in Darjeeling at Rs. 60 to Rs. 95 a maund in 1925, whereas the cultivators obtained on an average Rs. 30, sometimes as low as Rs. 12, because they had obtained advances from the ring of *Marwaris*, who control the trade. This is not an exception but the rule, for the system of financing is extremely complex as described in the appendix to the Report of the Babington Smith Currency Committee. A rough idea may be obtained from a study of the system at present obtaining in Assam. The big *Mahajan* gets his money from his Calcutta firm or bankers at 6 to 9 per cent. He charges 12 to 15 per cent. from the small *Mahajan* who in his turn levies anything from 18 to 30 per cent. on local traders. By the time, finance filters down to the actual cultivators the interest rate is anywhere between 24 and 60 per cent.

(3) Unnecessary Middlemen.

The small unit and the impecuniosity of the cultivator necessitate the employment of a large number of middlemen. It is true that for the marketing of food crops and low valued crops, there are fewer intermediaries than for commercial crops and high-valued crops. But even in the case of the former, there are far too many, especially if the producing areas are at a distance from the markets. Perishable commodities like potatos should change as few hands as possible. But at Poona there are at least five *adatyas* or brokers representing sellers through whom potatos must pass before they reach, not the actual buyer, but another intermediary, a representative of the buyer called a *dalal*. In the case of paddy in Bengal, it is collected by a village *faria* (small dealer) from the *rayat* (cultivator) and sold through a *paikar* (wholesaler) to a *bepari*, who is either a dealer on his own account or merely a commission agent, financed by another middleman higher up the chain. A *bepari* cannot sell the *dhan* or unhusked paddy direct to the mills but must carry it to an *aratdar* (godown keeper), who levies not only his usual charges but also a commission. From him the paddy goes to a *dalal* (broker), who charges Rs. 3 per 100 maunds on an average, and finally to mills.

(4) Their Malpractices.

These different classes of persons not only take middlemen's profits without rendering any commensurate economic service but they frequently practise rogueries of the worst description. In the Report of the Mango Marketing Committee published recently by the Bombay Government, a vivid description is given of secret buying without the knowledge of the producer. The *dalal* (buyer's broker) will not deal directly with the seller but only with an *adatya* (seller's broker) and bargains are struck secretly by manipulation under a cloth. Even in an organized cotton market like Amraoti, a Government officer on special duty recently found out from the books of different *adatyas* that the price paid to cultivators was often lower than the price obtained from buyers.

(5) Chaotic Measures of Weight.

Apart from this, there are malpractices on account of different measures of weight in use for different purposes. In the *Gur* (unrefined Indian sugar) market in Poona, the producer has to deliver 256 lb. per *palla* but the middleman sells at 240 lb. per *palla*. In the case of tobacco, the *adatya* buys at 300 lb. per *palla* and sells at 280 lb. per *palla*. Besides there is almost a bewildering diversity in measures of weight in different places, and even in the same place for different commodities. To give only one instance in Jalpaiguru (Bengal) the local weight is 93 *tolas* but Habigunge tobacco for which it is a great centre is dealt in on the basis of 80 *tolas*. Illiteracy on the part of the *ryot* is as much responsible for this state of affairs as is the action or rather the inaction on the part of the Government. As early as October, 1913, the Government of India appointed a committee to go into the matter and in their resolution, dated January 3, 1922, declared themselves in favour of adopting throughout India the system of weights at present in vogue on railways. But nothing further has been done.

(6) Corrupt Weighing.

The weighman (called *koyal* in Bengal) is an employee of the buyer and frequently manipulates the scales to the detriment of the seller. The evil is well-known in Bengal and loudly calls for reform. Even in the case of organized cotton markets, Rao Bahadur K. V. Brahma of the Berar Co-operative Institute is constrained to plead for platform scales in place of the present beam scales as a check to the knavery of the weighman. In fact, the justification for the existence of the Cotton Sale Society at Pachora (the only surviving society in Khandesh, and that even not a co-operative body in spite of vigorous propaganda) is simply that it secures fair weighment.

(7) Arbitrary Deductions.

At the time of weighing, various arbitrary deductions are made, some of which are enumerated below :—

(*a*) *vritti*, a customary allowance for religious and charitable purposes. The name differs in different parts of India but the practice obtains everywhere.

(*b*) *dhalta*, allowance for drying.

(*c*) *muthi kabari*, "handful" for staff.

(*d*) *kharcha* (also called *jharai bojai*,) allowance for bagging and

(*e*) *newaj*, deduction for mosques and Mohammedan charities.

(*f*) *koyali*, weighman's allowance.

(*g*) *hamali*, porterage charges.

(8) Adulteration.

Absence of grading lowers considerably the price of the produce. This is insisted upon in the Report of the Mango Marketing Committee referred to above. But in the case of export crops, grading is far more necessary. Unfortunately, however, unscrupulous dealers make every opportunity for making unjust profits. Very soon after the introduction of 4F American cotton in the Punjab, it was discovered that the *deshi* and 4F could be mixed without buyers being able to detect it. This could not be done at the *kapas stage* (cotton with seeds on) by cultivators, for the seeds were different. It was the middlemen, who were responsible for this adulteration.

Similarly in the old days when the basis for red wheat in the Punjab was 7. p. c. barely and 3 p.c. dirt, dealers used to mix up barley and dirt with consignments of wheat which were above this standard.

(9) Lack of Warehousing and Transport Facilities.

Warehousing and transport are very inadequately developed. If a cultivator lives away from a market, he is in a very difficult position indeed. He has to send his produce in the time-honoured bullock cart over bad roads at considerable expense. If he cannot obtain a fair price, he can neither store his produce in the distant market nor can he bring it back to his village. It is for this reason that small itenerary dealers like *farias* can carry on trade under such unfair conditions. Apart from this, railway transport is inadequate. There is a chronic shortage of waggons during the crop moving seasons, precisely when they are most urgently required. Freight is also very costly as will appear from the following table compiled by Rao Bahadur P. C. Patil :—

Railway Systems	Freight for carrying one ton of wheat through 200 miles.
United States	Rs. 7·56
Madras and South Maharatta Railway ...	,, 10·32
Great Indian Peninsular Railway	,, 11·06

(10) Different Marketing Methods.

There is no uniformity in marketing methods, rendering an All-India Act for regulating markets and licensing middlemen impossible. There are on the one hand several remote areas where barter is still the vogue, *e.g.*, in the outlying parts of Assam and the Agency and hill tracts of Madras. There are on the other, several highly organized markets where futures alone are dealt in even by cultivators *e.g.*, in Nandyl Cotton Market in Madras.

"Swat the Middleman."

How are these difficulties to be removed? Wherein lies the remedy? It is clearly impossible to follow a supine policy of *laissezfaire*, when the buyers and sellers are of such unequal economic strength. If the *rayat* can be properly organized and made independent of middlemen with their numerous malpractices, most of the evils, enumerated above will be removed. A systematic attempt "to swat the middleman" is therefore clearly called for. To quote the words of a report issued by the State of Massachusetts, "a long line of commission men, produce merchants, jobbers, hucksters, retailers and what not simply passing goods from hand to hand like a bucket brigade at a fire is not only inefficient and wasteful, but it is very costly. In these days, a hydrant and a line of hose are wanted."

Co-operation.

As soon as the question of eliminating middlemen crops up, co-operation is suggested as the remedy. But it is forgotten that co-operation is a world-wide movement which has assumed different forms in different countries in conformity with their history and their social and economic circumstances. Co-operative marketing being a kind of agricultural co-operation has almost endless diversity. There can be no artificial uniformity in respect of anything connected with agriculture, for that must obviously be a reflex of the people and the soil. A study of the systems prevailing in other countries will, however, be helpful, if it is possible to deduce certain general principles and correlate them with circumstances prevailing in India.

Necessity, the Mother of Co-operation.

The one fact that emerges clearly from a study of agricultural co-operation all the world over is that there must be the pinch of an impelling necessity. During the middle ages, when the Swiss farmers keenly felt the necessity of diminishing their toil and increasing their income by forming groups and delegating from among themselves by rotation one member for manufacturing cheese and another for selling it in a distant market, it is then and then only that *Fruitieres* came to be established. To give a modern instance, the little country of Denmark leads the way in agricultural co-operation at present. What is her history? Before the war of 1858, she had extensive agricultural and pastoral industries which had their markets in Germany. The loss of this market and the growing competition from America drove her to the production of breakfast table commodities and that for a different market. The history of Danish co-operation begins with the history of the need for this transition in Danish agriculture.* The story of co-operative marketing of wheat cotton and other staple crops in different parts of the world also points to some impelling necessity as the mother of co-operation. It may be conceded that there can be no country where this necessity is more urgent than in India. But the question is whether the people who are sought to be co-operatively organized *themselves* feel this necessity. In its absence, one cannot look for loyalty on their part to the society which is bound to prove a failure in consequence.

Leadership.

Necessity by itself cannot set up a co-operative organization. There must be leadership. Ireland had been suffering from a long agony of economic distress and political strife but there was no organized attempt at co-operation, before the advent of Sir Horace Plunkett with his gospel of "better farming, better business and better living." Similarly in the case of Finland which has been one of the best modern examples of what co-operation can do towards building up a prosperous agricultural country, it was the devoted work of the pioneer, Dr. Hannes Gebhard, "the father of Finish co-operation," which achieved success in spite of sparse population, poor communications, low level of popular education and lack of sympathy on the part of the ruling class. Beginning with co-operative production and distribution through the Pellervo Society in 1899, scheme for co-operative sale materialized into the Vallio Butter Export Co-operative Society in 1905, which in 1924 handled 92 per cent. of butter and 70 per cent. of the cheese leaving Finland. There is a general characteristic of this movement for agricultural co-operation which calls for more than a passing notice. There has been in its origin in every country and there has been retained throughout its growth, an idealism which has given to it something more than an economic impulse. Whether it was the patriotism of Denmark smarting under the defeat of 1858, whether it was the religious and social culture which provided the spring of co-operation in Belgium, whether it was the importance of character called for by the principle of unlimited liability preached by Raiffeisen, who was moved as no other man was moved by the agonies of German peasants in the grip of money lenders, —in every case there was something akin to religious fervour in the inception of the movement. No wonder, therefore, that inspiring leadership is a *sine qua non* for success. But although social reconstruction is now in the very air, evangelists for agricultural co-operation are rare in India whether among officials or among non-officials. In Bengal, the Co-operative Organi-

* The important discovery of the method of pasteurisation was the direct result of co-operative dairying in Denmark and has since spread to other countries.

zation Society is a non-official body with State subsidy, which is charged with carrying on propaganda in the countryside. Bodies like these in other parts of India must take the lead in the matter.

Clear Thinking.

The third lesson derived from a study of agricultural co-operation is the supreme need for having an accurate stock of the present position. A feeling of vague discontent with the existing order is not enough, even when brought home by an inspiring leader. There can be no appreciable improvement before there is systematic study of the present defects in marketing along with clear thinking about how they may be removed. As pointed out in a recent report to the Ministry of Agriculture and Fisheries on the lack of development of agricultural co-operation in Great Britain, the following questions must be answered before co-operative sale is attempted :—

(*a*) What are the present defects in marketing methods? Are they capable of improvement through co-operation?

(*b*) Have the sympathy and the goodwill of the local cultivators been adequately secured?

(*c*) Is the volume of business sufficient to maintain the society?

(*d*) Has enough provision been made for finance and also for godowns, plants and other necessary equipments?

(*e*) Will middlemen be sufficiently eliminated to effect an appreciable saving to cultivators through efficient grading, avoidance of waste, etc?

In other words, all details must be carefully threshed out in the light of experience gained in foreign countries and also conditions prevailing here.

Co-operative Sale of Fibres Abroad.

(a) Cotton.

To take one example, that of cotton, there is a wealth of foreign experience. U.S.A. which is by far the largest producer of cotton set up the American Cotton Growers' Exchange, driven by the crisis of 1920-21. It is a gigantic business organisation with its head-quarters at Memphis and agencies in all the principal cotton exchanges in the country. It has foreign agencies in the ports of Liverpool, Havre, Bremen, Barcelona, and Kobe, besides a large number of representatives at minor ports. There are thirteen member associations in the U.S.A. which effect all their foreign sales through it. One of them the Texas Association has adopted a scientific method of assuring to each farmer the proper price for his cotton. Each bale is carefully sampled and graded and "a co-efficient of relative economic value" assigned to it. The sale proceeds are distributed not on the basis of gross weigths supplied but the weights as multiplied by the appropriate "co-efficients." This may be antagonistic to the root idea of "each for all and all for each" but it certainly provides a stimulus to improvement in quality. Another member of the exchange, the Staple Cotton Co-operative Association, has specialised in effecting sales directly to spinning factories. The percentage of such direct sales has steadily improved as shown in the following table :—

Year	Percentage of direct sales of total sales
1921-22	53·0
1922-23	51·4
1923-24	89·8
1924-25	91·9

The expenses for marketing work out to 2·16 p.c. gross and 1·20 p.c. nett on an average for these four years. During 1925-26, the co-operative societies together handled 1,488,000 bales or 9·30 p.c. of the total production. In South Africa, co-operative marketing is in its infancy. In Egypt, the movement has not yet been started.

(b) Flax.

The story of co-operative marketing of fibres other than cotton is also instructive. For instance, let us take the case of flax. Before the war, the greatest flax exporting country was Russia. Marketing of flax has had a chequered history in that unhappy country. Leaving out the distant past, the only co-operative organization which rose to the dignity of a national union during the war was the "Central Union of Flax Growers" founded in 1915, with the double object of improving the quality of the produce and obtaining proper price for it by providing warehouses and arranging for efficient grading at the primary societies and also at the Union. During the Bolshevist regime, this Union and also other organizations like that of Hemp Growers were put out of business because they were not direct producers and the Soviet Government declared a monopoly of flax, leather, wool and other products. But co-operation cannot die. The Government were constrained to pass the decree of August 16, 1921, conceding to peasants the right to organise "artels" (agricultural co-operative associations) and also unions. In that year was formed the "Lnocentre" the present federation of flax growers' co-operative societies. During 1925, from 30 to 35 per cent. of the total export was furnished partly by this "Lnocentre," and partly by the "Centrosojus," the central organization of distributive co-operative societies.

(c) Silk.

A study of the marketing of silk is of special interest to a country with small units of production like India, for a commodity like silk can be produced most efficiently only in small lots, although it must be bulked, graded and standardised before sale. In fact, long before the Co-operative Law was passed, there had been set up marketing societies on indigenous lines in Japan. Most of the features of modern co-operative sale societies in Europe and America have, however, been subsequently incorporated. There has now been a clear cut division of societies for sale of (a) cocoons (b) spun silk and (c) silk goods, the second being easily the most important.* The following special features may be noticed. First, profits credited to reserves are still divisible in the proportion of goods delivered. Secondly, a special subsidy is granted to all members who hand in their entire outputs. Thirdly, compensations are paid if the price obtained by a society falls below the market price. Fourthly, the society frequently defrays the cost of cartage to induce members at a distance to send their goods. In Italy, the co-operative cocoon-rearing establishments started in 1920 not only eliminate bad cocoons with meticulous care, which is their main function, but also organise-co-operative sales.

(d) Wool.

The great number of identifiable varieties of wool makes the problem of grading much more difficult than even in the case of raw jute in the hands of Bengal *rayats*. The *dhalta* or drying allowance in the case of jute is nothing compared to the allowance which has to be made for dirt and grease

* In Bengal also, the co-operative societies for silk may be divided into (a) cocoon societies (b) reelers' societies (c) weaving societies. Sale societies are being experimented with.

in wool, ranging from 40 per cent. to 80 per cent. Unless scouring is controlled on behalf of the producer, he cannot hope to obtain anything like the proper price. The largest wool-producing country is Australia, where organized marketing dates practically from the conclusion of the war when there was an imperative necessity of liquidating war stocks. In Argentina, the next important wool producing country, co-operation is now being experimented with. In the United States, however, co-operative sale is in a much more satisfactory position. Of the total production of 266,110,000 lbs. in 1923, 53 district and local co-operative associations (half of which were formed since 1920) put on the market 19,647,861 lbs. The method of work of a typical society (Pacific Co-operative Wool Growers) was described in detail by its general manager Mr. Ward before the American Institute of co-operation in 1925. Briefly the aim is to deliver carefully graded wool direct to mills and reputable wool merchants after scouring it properly in the extensive warehouses. Sales are carefully regulated in accordance with market demand. It has been claimed that "during four years of successful operation, the Association has marketed about 16,000,000 pounds of wool and mohair at prices ranging up to 15 cents per pound nett more than the average outside price for similar wools." In the Union of South Africa and in Canada there are organisations for the co-operative marketing of wool, which do not however have any feature of special interest to India.

Marketing of Cotton in India.

Before we discuss the co-operative marketing of fibrous products in India, it will be necessary to review somewhat in detail the conditions at present obtaining in the markets for different fibres in the country. Jute is of provincial importance, but cotton is of more than parochial interest. In C.P. and Berar, there is a big cotton market at Nagpur and a large number of smaller markets. But paradoxical as it may seem, there is no auction of goods in most markets, only there is an auction of prices. In other words, the buyers auction amongst themselves the highest price to be paid to the *rayat* on the receipt of telegraphic advice from Bombay, before a single bale of cotton is actually bought. It is only the lucky few among *rayats* who have their cotton regarded as of the standard quality. But the majority have to agree to a considerable reduction, varying from 28 to 40 lbs. per cart on the plea of dirt dampness, late picking or any excuse that may be invented. In markets more happily placed, where there is free competition among buyers and sellers, the *rayat* gets about Rs. 2 per *khandi* more than elsewhere. In Bombay (including Sind and Indian States). marketing is in an equally deplorable condition. There is a general preference for sale to petty traders rather than sending the goods to a distant market* where there is frequently a dispute about the rate after weighing has commenced. In such cases improved varieties introduced by the Agricultural Department cannot get anything like their proper price. It was for this reason that auction markets had to be organised in Dharwar for Broach cotton about the year 1910. In Madras there are three principal markets at Nandyal, Adoni, and Bellary. The first has already been referred to. In the second, agents of buying firms inspect the cotton which is taken to the highest offerer who, however, accept only a few *boras* (bags) and reject

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* In the course of an inquiry undertaken by the Indian Central Cotton Committee in Khandesh it transpired that

680 Growers (84·4 p.c.) sold *kapas* in Villages;
97 ,, (12·0 p.c.) ,, at markets through *adatyas*.
29 ,, (3·6 p.c.) ,, both in villages and at markets.

Only 26 cultivators ginned their cotton and sold the lint. 79 out of 97 men interviewed complained of unfair deductions in price.

the rest, or accepts them only under rebates. In Bellary, cotton is frequently left with the commission agents who advance 50 to 60 per cent. of the price, adjust the balance on the basis of their own rates, after deducting interest, rent, insurance, commission, etc. The interest is anything between 10 and 30 per cent. The commission usually varies between 1½ and 3 per cent. but higher rates are not unknown. If a dealer carries on the trade on his own account, he charges as much as 6 per cent.

Cotton Sale Societies in India.

In spite of these defects, no sale society has yet been started for cotton in the Madras Presidency, although there are few societies for the marketing or arecanut and rice. In C.P. there are three cotton sale societies, which do business with members and non-members alike. A bonus is paid to members at the end of the season after adjustment of accounts. In Khandesh, as stated above, there is only one society at Pachora, all the rest having been closed, the reason being (a) inefficient management, (b) inadequate finance, (c) lack of propaganda and (d) hostility of merchants. The last feature has been very much in evidence in Dharwar also. For instance, the Gadag cotton Society was started under very good auspices in 1917. The success of the society created uneasiness among middlemen whose pockets were touched. They organised a boycott in 1919, which was called off after suspension of business for 10 days when the society conceded increased commission to them and recognized their lien on the goods of cultivators, who had obtained advances from them. This was not however the end of the trouble. By 1925, the middlemen found out that they were being gradually excluded and organised a boycott on a more elaborate scale. First, they prevented buyers from attending the society's auctions by every means in their power. Secondly, they set up rival auctions in which they offered slightly higher prices for small lots. Thirdly, they prevailed upon cartmen, *hamals* (porters), ginning and pressing factories not to touch the society's cotton. Besides, they trespassed into the society's premises and committed various mischiefs on the plea that a *dalal* was a part-owner of the plot on which the building stood and had given notice to quit. They also spread false stories about the transfer of the Assistant Registrar of Co-operative Societies who was looking after the society. Even now the boycott continues but happily the society has gradually increased its business as indicated below :—

Year	Value of cotton sold	Profit capital	Share	Number of Individual	Members Societies
	Rs.	Rs.	Rs.		
1920-21	352,950	119	13,353	995	6
1921-22	394,309	5,590	13,762	1,005	27
1922-23	683,347	8,987	15,589	1,069	29
1923-24	1,820,318	18,847	19,467	1,111	63
1924-25	693,233	13,184	37,914	1,327	70
1925-26	1,517,696	16,565	41,796	1,697	85

Marketing of Jute.

The marketing of jute follows in the main the same system as for paddy which has been described above. There are *farias*, *beparis* and *aratdars* ; their charges are, however, higher, specially in years of short crops, and vary from 2 annas to 6 annas per mound in the case of the first class of middlemen, 4 annas to Re. 1 in the case of the second and 4 annas to 6 annas in the case of the third. Sometimes, however, when there is a convenient *hat* (market on stated days in the week) in the locality, the *rayat* may sell his jute directly to

a *bepari*. Most of the *aratdars* of jute have rude applicances for baling. These bales are not of the standard weight of 400 lb. nor of the standard size of 10 2-5 c. ft. of properly graded jute, which are necessary for the purpose of export. They are called in fact *kutcha* bales but are subject to change for this crude pressing. Then there are the necessary charges for bringing the jute to Calcutta, on account of handling, storing freight, insurance, etc., which vary from 2 annas to 4 annas. The price at this stage and the price in the villages differ by about Rs. 2-8 as. on a maund, the difference amounting to anything between 20 per cent. and 30 per cent. of the ultimate price, say 25 per cent. on the average. The *kutcha* bales are taken to a power press in Calcutta in order to be made into *pucca* bales. The baler quotes f.a.s. prices to local mills as well as to shippers, the latter quoting c.i.f. prices. These sales are very seldom direct; a broker intervenes, sometimes with an under-broker below him.

Co-operative Sale.

It is no wonder, therefore, that co-operative sale of jute is now being experimented with in Bengal. There were five societies, which worked during the last season but 10 are being organised this year. The movement is reported to have great possibilities, not by an ardent co-operator but by a hard-headed business man in the course of his evidence before the Agricultural Commission. The societies have already established a good reputation for their mark, through the common selling agency for all goods of co-operative societies in Bengal, viz. the Calcutta Wholesale Society.

The working capital of a society consists partly of share capital and partly of cash credit advances obtained from the neighbouring Central Bank and the Provincial Bank. All of them have appointed European or Armenian managers with experience of jute and have acquired suitable godowns and presses. The jute section of the Chandpur Sale and Supply Society has purchased a steam launch for quick transport. Jute is purchased outright from the *rayats* either directly or through *beparis*, paid and financed by the society, their work being checked by supervisors appointed for the purpose. Jute is delivered directly to a Calcutta Mill or to an export firm, the sale having been effected in the meantime through the Co-operative Wholesale Society. The societies discount with the Provicial Co-operative Bank the bills in respect of these consignments and thus square their cash credit accounts.

Co-operative Sale of Wheat Abroad.

Co-operative marketing of wheat has passed through two distinct stages in foreign countries. In the first stage the producers from local or regional associations to set up and manage in common an "elevator," which has been described as a " hospital, for drying grain if it is wet, cleaning grain if it contains foreign matter, clipping grain if it is sprouted, scouring grain if it is musty, and conditioning grain so as to improve its appearance and keeping qualities." Thus it is essentially a grading and storing institution, although it frequenly arranges sales on a commission basis. But the elevator system really elevates cultivators, when they are prevailed upon to discard individual sales and deliver their products into a common "pool" under a long period contract. This is the most advanced stage of co-operative marketing in grains. But it is really a copy of the old methods of the Danish co-operators which the fruit-growers of California have followed with equal success. Canada, the largest exporter of wheat has adopted the "pooling" method since the abolition of the marketing agencies set up during the war. Alberta started the movement in 1923; Manitoba and Saskachewan followed in 1924. After this the three provinces organised a common agency, the Canadian Wheat Producers Ltd. which handled in 1925-26, 187,500,000 bushels, which

is two-thirds of the total wheat export of Canada and over one-fourth of the total wheat dealt with in international trade in the whole world. The agency has 36 offices in importing countries and sold directly to mills as much as 65 per cent. of this vast amount. In Australia also during the past war period, three separate organizations were set up for (a) Victoria, (b) Western Australia, (c) and South Australia with New South Wales, which together handled 70 per cent. of the total export from Australia. In the United States, the elevator system is still in vogue, handling in 1924-25, 27,637,000 bushels of wheat.

Marketing of Wheat in India.

The method of marketing of wheat in India is still unsatisfactory, although some improvement has been recently effected. The old basis for the sale of wheat has been referred to above. The new basis for up-country sales is 2 per cent. barley and 1½ per cent. dirt. But in Karachi it is still a "parcel trade," that is to say, different parcels of wheat are mixed together to arrive at the port standard of 5 per cent. barley and 3 per cent. dirt. In England the present basis is 2 per cent. barley and no dirt. Dirt up to 1 per cent. is charged at the rate of wheat. Any extra dirt is charged at twice that rate. The Agricultural Department has introduced new varieties like the Punjab II and 8-A but have not organized auctions for these as in the case of improved cotton referred to above. It is the storage system, however, which loudly calls for reform. Even if we leave out the method of storing grain in the open on a plinth covered by a tarpaulin as a purely make-shift arrangement, the other so called permanent methods have also grave defects. If warehoused in bags, about 2½ per cent. is wasted through weevil infection caught from old bags or from crevices in the godown. If stored in pits lined with straw and plastered with mud and cowdung, the quality deteriorates so much that the loss amounts to 5 per cent. Apart from these, there is the loss inseparable from manual labour which may be estimated at 1 per cent. Bags cost 3p. per maund on an average and incidental expenses aggregate from 1a. 3p. to 2a. 3p. per maund.

Elevator System in India.

The obvious remedy for these evils is a system of elevators. There is at present one elevator at Lyallpur in its lonely eminence and absolute waste. But it has been rightly pointed out that in order to give the system a fair trial, there must be elevators throughout the wheat tract and also terminal elevators at the ports. In other words, there must be a concerted plan in which railways, Government, banks, co-operative societies,—in fact every agency connected with crop-moving must play its part. It has been suggested that it is railways which should undertake the task, for, in that case, wheat would be under the control of a single public body from the time it leaves the *rayat* till it is exported or consumed. They should offer reduced rates for grain in bulk, for transport and handling would be quicker, involving less wear and tear to the rolling stock. Government should acquire the land for elevators, grant a limited monopoly for some years,* and guarantee the receipts issued by those elevators after proper supervision. It has been urged that these receipts should be declared negotiable, in order to facilitate advances against them. That may not be necessary but they should certainly be included among the mercantile documents of title to goods transferable by endorsement. Financing will not be very difficult, for, as estimated by a competent authority, at no time is it necessary to hold more than 400,000 tons valued at Rs. 5½ crores. As a matter of fact, the Imperial Bank of India have agreed to provide the money under reasonable safe-

* The idea of starting government elevators for military purposes should be abandoned

guards. Co-operative societies should make advances against the elevator receipts in the first instance and rediscount them later with the Imperial Bank. They must also arrange to collect the produce by a vigorous propaganda, laying special stress on local trade abuses.

Conclusion.

The paper is already much too long and must now be brought to a close. It has been in the main an academic study without the formulation of definite plans of action, which can only be outlined on the basis of details for each locality, carefully investigated by a small expert committee. But even in the absence of such a detailed study, one can safely say that there is no reason for despair. Market conditions to-day are no worse than what they were in advanced countries a hundred years ago. To make up this leeway, there must be a sustained and vigorous propaganda in favour of co-operative marketing and active canvassing with a view to the wide adoption of the principal of local option for a "pool" subject to some penalties, if that is unfortunately necessary. This may be objected to on theoretical grounds. But those who have any experience of the conditions actually obtaining in India and those who have carefully studied the evolution of co-operative marketing in other countries, will not shrink from sacrificing theory, fired by the vision of an India, which may yet serve as a model to the rest of the world for what can be achieved through agricultural co-operation, through "better farming, better business and better living."—*The Bengal Co-operative Journal,* Vol. XIII. No. 3. 1928.

Land Mortgage Banks for Bombay.

THE formation of Land Mortgage Banks has for some time been a subject of interest not merely in the Bombay Presidency but also in other parts of India. Three provinces, namely, Madras, the Punjab and Burma, have already introduced the system of Land Mortgage Banks. The need for similar institutions in this Presidency has been recognized. The Co-operative Societies are able at present to meet the requirements of their members for ordinary agricultural purposes. It is, however, not possible for them to raise capital for long-term loans for the purpose of redemption of the debts of agriculturists and for the improvement of their lands. The long-term capital in the Co-operative Movement at present consists partly of (1) the shares and reserve fund —only a portion of which, however, can be utilized for long-term loans, as the remainder has to be kept as a fluid resource; (2) debentures of the Provincial Co-operative Bank, the interest on which is guaranteed by Government; and (3) the amount placed at the disposal of the Registrar of Co-operative Societies by Government for distribution as *tagavi* to members of Co-operative Societies.

In order that new sources of capital for sufficiently long periods may be made available, the formation of Land Mortgage Banks is considered to be the best solution. A definite move was made in this direction when the Divisional Conference held in Gujarat appointed a Committee to consider the question. The matter was later discussed by the Directors of the Provincial Co-operative Bank and the Registrar of Co-operative Societies. The Registrar then submitted to Government certain proposals which were placed before a conference under the presidency of the Minister of Forests, Excise and Co-operation to which were invited representatives of the Provincial Co-operative Bank and Imperial Bank of India. This conference appointed a small Committee to formulate a scheme and submit it to Government. This scheme with slight modifications, has now received the general approval of Government who have directed that it shall be tried as an experimental measure and that two Land Mortgage Banks shall be opened in the first year, one in the Broach District and one in the Dharwar District.

The details of the scheme are as follows: It is decided to provide for long-term loans to agriculturists for the following purposes:—

(a) The redemption of land and houses of agriculturists.

(b) The improvement of land and methods of cultivation.

(c) The purchase of costly agricultural implements and the purchase of installation of agricultural plant or machinery.

The machinery of organization will consist of the Provincial Co-operative Bank as apex bank and primary units consisting of local Land Mortgage Banks (for Associations). The Provincial Co-operative Bank will take up the work as one of its ordinary activities without any change in constitution

or organization. It will provide the main source of finance by raising debentures of the value of Rs. 9½ lakhs at 4 per cent. In order to lend support to the scheme Government will purchase debentures to the extent of Rs. 5 lakhs at such discount as will ensure that they do not lose on the transaction.

The area of the local unit of operations will be a fairly large tract which will ordinarily be a revenue district but it need not necessarily be co-terminous with one. The members of the local banks or associations will be holders of agricultural land who are borrowers and other members nominated by Government. Each borrower will subscribe to shares in the proportion of one-twentieth of his borrowings. The money thus borrowed will not be kept by the local bank. It will either be invested in Government securities and the securities deposited with the Provincial Bank or it will be directly invested in the Provincial Bank at the best rate of interest which the Bank can give. The local banks will thus have no concern with the finance beyond receiving and investing the share money and acting as the intermediaries for advancing the loans to borrowers and the whole business of finance will to this extent be done by the Provincial Bank. Each local Bank will require an expert valuer of land. He will be of the status of an Aval Karkun and will for the present be supplied and paid by Government. Loans will be made on first mortgages up to a limit of 50 per cent. of the value of the land mortgaged.—*The Mysore Economic Journal*, Vol. 13, No. 10, October, 1927.

Eri Silk: Its Possibilities.

M. N. De,

Superintendent, Government Silk Institute, Bhagalpur.

ASSAM is the home of Eri Silk. Eri silk is the product of an insect like mulberry, tasar and muga and other kinds of natural silk. It feeds on castor and is fully domesticated. Hitherto it has been cultivated in the Assam Valley, but now with the facilities of obtaining healthy eggs from Bhagalpur and other places, its cultivation can be carried on in Behar and Orissa from the beginning of July, as soon as the monsoon breaks out, to the end of February, when hot and dry winds do not begin to blow. It is unsuited during March, April and May, when hot and dry winds continue to blow and the atmosphere is laden with minute particles of dust. The rearing is very simple and can be done on a small scale when once it has been seen. The production of thread and cloth offers no difficulties to people accustomed to spinning and weaving cotton, and where there is a demand for light profitable work, such as can be done by women and children. With the favourable climatic conditions of the Province, the industry is capable of wide extension as a Cottage Industry where castor grows abundantly. The worms are strong and stand diseases and rough handling. It is pre-eminently suited as a cottage industry and the work involved is simple and inexpensive and can be easily carried on in Tatti Houses. The cultivator can expect to derive an extra income by providing work for his family during the recess between agricultural operations. The margin of profit in the industry is however very small and the utmost economy has to be practised while rearing the worms. The rearing should be done on a small scale in one of the dwelling rooms; it will not pay if done on a large scale with hired labour. It serves as an excellent object lesson for studying insect life for children in schools. Eri cocoons cannot be reeled like mulberry, tasar and muga cocoons; they are spun into thread like cotton. There is no killing of life in any of the processes and therefore the Jains and the Buddhists prefer this silk to other kinds of silk. The worms thrive best during the rains when the temperature and humidity vary from 80 deg. to 85 deg. Farenheit and 80 to 95 per cent. respectively. They do not grow well when the temperature is below 60 deg. For above 100 deg. F the humidity is lower than 45 per cent.

In Behar and Orissa there are about 44,000 acres of land under castor. If the leaves are utilized in feeding Eri worms, about half a crore of rupees worth of cocoons can be produced annually from them in addition to castor seeds.

The industry is one of that is best taken up by land-owners or others who are able to induce groups of cultivators to do the rearing of the worms and whose families will do the minor work of cleaning the cocoons, boiling them and spinning them into thread. The thread so produced can be woven by any weaver accustomed to cotton weaving. We do not recommend rearing very large number of worms in one large rearing house, but we advise that in each village many should rear small broods in their own houses. For this reason we look to the land-owners and Zamindars, co-operative societies and the educated middle class people to commence and to organize the industry.

A Paying Proposition.

Sixty-six and half seers of green cocoons with insects inside can be produced from 16,000 eggs. About 300 green cocoons with insects inside weigh one seer. About $2\frac{1}{4}$ chittaks of empty or pierced cocoons can be got from one seer of green cocoons. About 2,500 dry and empty cocoons weigh one seer. About 75 maunds of castor leaves and 10 mds. of castor seeds are generally produced from one acre of land annually. About 19 maunds of leaves are required for 16,000 worms; so that from an acre of land about one maund of dry cocoons valued at Rs. 120 plus about 10 maunds of castor seeds, valued at Rs. 50 can be got annually. About 25 seers of spun thread can be produced from one maund of cocoons, costing about Rs. 3 per seer for spinning. The thread can be sold for about Rs. 250.

From the thread a piece of cloth about 150 yards long and 54 inches broad can be made costing about Rs. 70 for weaving. The piece can be easily sold for about Rs. 600, the present rate for a yard of hand-spun Eri cloth being about Rs. 4.

The cost of cultivating and manuring an acre of land does not exceed Rs. 25 in one year. We always advise peaple to grow castor in the homestead and rear worms from the leaves. One woman and a girl can rear 16,000 worms at a time in about 20 days. In the early stages, for about 10 days one woman only can manage to look after the worms, but in later stages, the services of another girl are necessary, as the worms eat voraciously and require constant looking after.

Like other moths, the Eri worms pass into eggs, caterpillars, chrysalids or pupae and moths. The life history of the worms is as under:—

Eggs hatch on the 7th day after oviposition in summer but on the 20th day in winter.

The caterpillars mature and spin cocoons in 18 days in summer but in about 35 days in winter.

The chrysalids or pupae remain in the cocoons for about 17 days in summer, but for about 40 days in winter. The female moths oviposit about 150 eggs on the second and third day after emergence and live for about 5 or 6 days, gradually lose their vitality and then die. Moths have no function of eating or drinking, the worms are fed only in caterpillar stage. The worms complete the cycle in about 50 to 55 days so that about 5 to 7 crops in a year can be got from the same brood.

There is a great demand for Eri cocoons in England and the merchants will purchase them in large quantities, but it is more economical to spin and weave locally. The Superintendent of the Bhagalpur Sik Institute will purchase all the Eri cocoons produced in Behar and Orissa at about Rs. 3 per seer of dry and empty cocoons.

Rearing Process.

The rearing is simple. Bamboo trays and baskets, bamboo machants for keeping the trays, a tatti house and castor leaves are the only requisites for rearing the worms. Literature on Eri silk worm rearing in English, Bengalee and Oriya are available. Expert advice is obtainable from the Bhagalpur Silk Institute. Eggs in small quantities are supplied free of cost from the above institute if they can be spared when requisition is sent for them. Eri worms suffer from diseases such as pebrine and flacheri, but they can be easily protected from them if cleanliness and rules of rearing are observed. The enemies of Eri worms are spiders, ants, lizards, silk worm flies, cockroaches, rats and birds, and should be guarded against.

The alternative food plants of Eri are keseru and papya; other indifferent food plants are champa, cabbages, potato, plantain, sisam, etc.

Eggs are kept in a periorated box in a piece of cloth or paper. They change into a light blue colour before hatching. Tender and soft leaves are put over the newly hatched worms which crawl up to feed upon them. After about ten minutes the leaves are turned upside down, so that a sufficient number of worms can crawl on them. Then the leaves are transferred to a tray with the worms.

Worms change colour with their growth. They moult or cast off their skin four times in the caterpillar stage. They look sick and do not eat at the time. They should not be disturbed at the time. They change into chrysalids within the cocoons and they come out of the cocoons as moths. Before moulting these worms decrease in size, remain motionless and stop feeding. Serve leaves, when all the worms moult. Keep worms of the same day of hatching in one tray. When all the worms come out of the moult, serve entire leaves and when they crawl upon the leaves, transfer those worms which have not crawled on fresh leaves with the broken pieces of dry leaves on which they crawl. Throw away the faeces and dry leaves. Clean trays once a day. Burn or bury weak and diseased worms whenever they are seen. In hot and dry weather sprinkle the floor with water three or four times a day. The leaves need not be chopped but while serving leaves may be torn into two or three pieces in the earlier stages. Young worms require tender leaves but harder leaves should be served as they grow older. Do not serve very hard and old leaves as they bring diseases. Fresh leaves can always be given safely to worms. In hot and dry weather feed oftener if the leaves dry up. In winter and on rainy days the number of feeding should be less. Do not handle the worms too much. Sprinkle water on the floor of the rearing roof if it is hot in summer Do not feed the moulting worms. Rear little but rear well. The quantity of leaves to be served each time should be determined by the appetite of the worms, 16,000 worms should eat 3 tolas' weight of leaves on the first day and 1¾ maund on the last day. Do not disturb the moulting worms. In case some worms do not moult uniformly they must be transferred to another tray with the leaves served to time. The worms will not die if they remain without food even for 20 hours after casting off their skin. The newly hatched worm is about 1 6th of an inch in size, after the first, 2nd, 3rd and 4th moultings they grow 3 8th and 2½ inch respectively. On attaining its full size the worm grows to about 3½ inches in length. Exchange of seed or eggs from distant places once every year should always be undertaken. Castor is sown in June or July after the first fall of rain or in October. About 10 seers of seed in an acre of land is required for sowing. Castor require rich land containing potash. It exhausts the soil very soon, so cowdung manure and neutral ammonium sulphate should be applied every year.—*The Mysore Economic Journal.* Vol. XIII. No. 12, 1927.

Meetings, Conferences, etc.

Board of Agriculture.

Estates Products Committee.

Minutes of the Thirty-eighth Meeting of the Estates Products Committee of the Board of Agriculture held at the Head Office of the Department of Agriculture, at 2-30 p.m. on Tuesday, July 10th, 1928.

Present:—The Director of Agriculture (Chairman); The Government Mycologist; The Government Entomologist; The Government Agricultural Chemist; The Secretary, Rubber Research Scheme, (Ceylon); Commander C. Goolden; Dr. C. A. Hewavitarne; Messrs. E. F. Home; J. Fergusson; H. D. Garrick; Wace de Niese; G. Pandittasekera; G. R. de Zoysa; R. G. Coombe; D. S. Cameron; J. Horsfall; J. B. Coles; R. W. Roy-Bertrand; R. P. Gaddum; A. W. Buxton; C. E. A. Dias; C. A. M. de Silva; A. T. Sydney Smith; E. C. Villiers; G. Brown; and T. H. Holland (Secretary).

Visitors:—Messrs. N. K. Jardine; F. P Jepson; M. Park; A. Macherman; A. B. H. Trimmer; and H. Leigh.

Letters and telegrams regretting inability to attend the meeting were received from Gate Mudaliyar A. E. Rajapakse; Messrs. J. W. Scott; H. L. De Mel; J. H. Armitage, A. C. J. Wijeyakoon; C. C. du Pre Moore; E. Maberley-Byrde; J. W. Oldfield; F. R. Dias and J. D. Dunlop.

Agenda Item 1.—Confirmation of minutes.

The minutes of the last meeting having been circulated to members were taken as read and confirmed.

Agenda Item 2.—Appointment of Members of the Committee.

The Chairman announced that Government had drawn attention to the fact that only the full Board of Agriculture was empowered to elect members to committees. The following members were therefore oo-opted as members of the Estates Products Committee pending their election at the next full meeting of the Board:—Messrs. J. W. Oldfield; J. Fergusson; F. W. Keith.

The following members were appointed to act on the committee. Mr. Felix R. Dias in place of Sir S. D. Bandaranaike and Mr. E. F. Home in place of Mr. Gordon Pyper.

Agenda Item 3. Travelling Expenses of Members of the Board of Agriculture.

The Chairman mentioned that this question had been raised a year ago and he had placed the matter before Government. The Finance Committee had not felt able to agree to the payment of all expenses of members but had subsequently agreed that Unofficial members of the Board of Agriculture who cannot attend meetings and return to their stations by train within one day should be refunded for each meeting they attend the equivalent of a first class rail fare from their nearest station, whether they proceed by rail or motor car.

Mr. R. G. Coombe who had originally brought this matter up thanked the Chairman for the action he had taken in the matter and the Finance Committee for the concession granted.

Agenda Item 4.—Progress Report of the Experiment Station, Peradeniya, for the months of March and April, and May and June, 1928.

The Chairman reviewed these reports.

Referring to the report on soil erosion experiments Mr. R. G. Coombe said that he would like to see an experiment laid down with the object of comparing the results of weeding with scrapers and with a type of tool now used in place of scrapers by some estates. He offered to supply a sample tool.

The Chairman replied that it might be able to carry out such an experiment in Area 6 at a future date.

Agenda Item 5.—Rubber Manurial Experiments 1927.

Mr. Holland reviewed the final report on two Manurial experiments which were discontinued at the end of 1927.

The Chairman said that the reports emphasised the difficulties in conducting manurial experiments with rubber owing to the variability of individual yields of trees. He referred to Bulletin No. 62 on Field Experimentation with Rubber which suggested a field technique based upon the latest statistical methods. In England it had now been decided that for manurial experiments with fruit trees it was desirable that all trees should be on stocks of the same value; seedlings were therefore of no use and only marcots or other vegetatively produced stocks could be used. The individuality of trees was such that the utmost precautions were necessary in order to secure results of statistical value.

Referring to Bulletin No. 82 Mr. Roy-Bertrand said that he did not think the type of experiment recommended could be laid down on an estate. He contended that in such small plots the fluctuation of the yields of individual trees from year to year would be a potent factor, and mentioned other difficulties. He also mentioned that the trees from which Mr. Lord had drawn his figures were all progeny of No. 2 Tree Heneratgoda and smaller deviations in yield from such could be expected than from mixed seedlings. The type of soil also often varied largely on a single estate, and if a manurial experiment were confined to small areas the results might not be applicable to the estate as a whole. In such small plots moreover losses of trees from disease or accident would seriously prejudice the issue. He considered that larger plots than those recommended should be used.

Mr. Robert de Zoysa enquired whether the manuring had affected the incidence of disease in the Peradeniya plots.

Mr. Holland replied that the disease incidence in all plots had been negligible and that no information could therefore be deduced on this point.

The Chairman dealt with the various points raised by Mr. Bertrand and stated that adequate guard rows or margins were provided for, that plots should be duplicated at least six times and should be randomised. It is only by such means that accurate results capable of statistical treatment could be secured and it appeared to be desirable to await the further results of the Rubber Research Scheme manurial plots before laying down another series.

Agenda Item 6.—Report on Rubber Tapping Experiments 1927.

Mr. Holland briefly reviewed this report.

The Chairman drew attention to the superior yield obtained from the use of a V cut and also to the absence of Brown Bast in plots tapped every three days. He said that undoubtedly Brown Bast was going to be a serious problem in the future and suggested that a system of tapping every three day with a V cut was worthy of consideration by estates.

At this stage the Chairman took up the question of a letter written by Mr. Sydney Smith referring to an article which appeared in the *Ceylon Observer* for June 2nd, 1928, on Varieties of Para Rubber. The article in question suggested that Ceylon rubber was of an inferior white variety while a black variety of superior yielding powers was in the hands of the Dutch. The Chairman referred to Akers' report on Rubber in the Amazon Valley and read an extract from that report. He said that Para Rubber in South America was mainly divided into those varieties which yielded "Hard Para" and those which yielded "Soft Para." The former were mainly found in the upper reaches of the Amazon and the latter in the lower reaches. Wickham's original seed had been collected in the lower reaches but by good fortune he had collected seed near the crest of a slope containing types of Hevea producing a good quality product. The Dutch were in possession of a few trees of the so called "Black Variety" grown from 5 seeds secured by Dr. Cramer from a tree growing at Ranoes from the Acre district of Brazil but information received by him personally from Dr. Cramer some years ago was to the effect that this variety showed no superiority in yield. The difference between the varieties was not a question of yield but of the quality of the rubber produced.

The Dutch had considered the introduction of fresh types from South America but had decided against the proposal on account of the danger of introduction of South American leaf disease. Ceylon had also prohibited introductions from the Western Hemisphere. Ceylon Rubber trees produced a product acceptable to the market and he thought that by selection of high-yielders the best possible results could be anticipated. Some species of Hevea produced a useless product and he

considered Ceylon growers should be warned against such introductions. In some Colonies where such introductions had been made considerable hybridization with the true *Hevea braziliensis* had taken place. He undertook to make enquiries regarding the trees at Pasir Coting, Java, referred to in Mr. Akers' report.

Mr. Sydney Smith said that the Chairman's answer was most reasoning and he considered that the facts should be made public.

Agenda Item 7.—Chilaw Coconut Trials 1927—Discussion of Results.

It was decided to postpone the discussion of these results till the next meeting.

Agenda Item 8.—Tea Tortrix Returns—Consideration of.

The Chairman said that the returns which had been circulated to members showed a general satisfactory co-operation on the part of the planting comunity. He appealed to those estates which were not already maintaining separate pest gangs to do so. He mentioned that the incidence of tortrix in the Southern Province was practically negiligible and asked for the opinion of the Committee as to whether the Southern Province should be excluded from the proclaimed area.

Mr. Robert de Zoysa and other members were of the opinion that the Southern Province should remain included in the area and the Committee agreed that this province should not be excluded.

Mr. Sydney Smith pointed out that the next three months were the most important ones for the prevention of Tortrix attack and suggested that the attention of estates should be drawn to the fact.

Mr. D. S. Cameron supported this suggestion.

The Committee being in favour of this course the Chairman agreed to send a circular to all estates to that effect.

Agenda Item 9.—Shot-hole borer Regulations—Permits for Removal of stumps.

The Chairman gave figures showing large increases in permits issued which indicated that the permit system was valued. There were nevertheless difficulties in working the regulations. He had discussed these with the Plant Pest Inspector, Central, and now put forward a suggestion for the registration and classification of all nurseries according to the class of plants they produced.

He asked Mr. Jardine to outline the present position.

Mr. Jardine explained the difficulties involved in the present system. He mentioned that the high prices ruling had greatly stimulated the sale of plants. He exhibited specimens of healthy well grown plants and very poor unhealthy plants both of which had recently been sold at the same price. He said that there were 9,000 nurseries now registered and these were inspected as often as funds and staff permitted. He explained the advantages of classifying these nurseries into grades in the interests of the production of better plants.

Mr. Wace de Niese suggested that something should be done to educate the buyer of plants to be more discriminating in his purchases.

The Chairman suggested that the scheme of grading nurseries would achieve this.

Mr. Sydney Smith dwelt on the danger to the district in which the buyer of unhealthy plants lived.

After further discussion the meeting agreed that definite proposals for the registration and grading of nurseries should be placed before the next meeting of the Committee.

Agenda Item 10.—Tea Termites—Report by Assistant Entomologist on his visit to America.

Mr. Jepson explained the object of his first visit to America. A great deal of work on Termites had been done in America and Dr. Synder was probably the greatest authority on the subject. He reviewed his report giving the results of his enquiries. He detailed the Paris Green treatment in fruit orchards.

Mr. Geo. Brown enquired whether the arsenic contained in the Paris Green with which treatment was suggested had any deleterious effect on the fruit of fruit trees.

Mr. Jepson said that this question was of great importance and was being closely investigated.

The Chairman said that the service of the Government Analyst had been arranged for in connection with the contemplated experiments now being planned by Mr. Jepson.

Mr. H. D. Garrick represented that the publication of Mr. Jepson's report was undesirable. The treatment should be thoroughly tested in experimental areas

before the publication of the report. Otherwise harm might be done to the Tea Industry.

Other members who had desired the early publication of the report fell in with this view and it was agreed that Government should be requested not to carry out their intention of publishing the report as a sessional paper until the trials now being started had been completed and definite data secured.

Dr. Hewavitarne enquired whether the treatment should be carried out in wet or dry weather.

Mr. Jepson replied that until the efficiency of the treatment was proved this question could not be answered.

Agenda Item 11.—Rubber Bud-grafting Proposals.

An extract from the Government Gazette No. 7651 of June 29th, 1928, giving particulars of the sums to be applied to the work to be undertaken, viz;

Experiment Station, Peradeniya		Rs. 67,500·00
Seed Gardens	...	,, 47,500·00
Bud-wood nurseries	...	,, 3,000·00

The following is a statement of budded rubber on Experiment Stations of the Department of Agriculture and Rubber Research Scheme at the end of May, 1928:

Experiment Station, Peradeniya ...	398
Experiment Station, Kegalle ...	335
Experiment Station, Kuruwita ...	37
Experiment Station, Bandaragama...	15
	835

These plants were alive at the end of May, but some were still dormant. It is possible that some of them will die, as losses have been considerable in 1927-28. For instance, at Kegalle 130 budded stumps have died, at Kuruwita 98 budded stumps, and at Peradeniya 102 budded stumps.

It is, however, expected to have all vacancies in the areas filled before the end of this year.

The Rubber Research Scheme had on its Experiment Station at Nivitigalakale 277 budded plants growing at the end of May, but re-budding of all failures of the first 13 acres opened was begun early in June.

Bud-wood nurseries have been established at Nivitigalakele, Peradeniya, and Heneratgoda and arrangements made for further nurseries of 26,500 seed to be picked from selected high-yielding trees of Heneratgoda, individual records of which over one year's tapping show yields of not less than 20 lb. of dry rubber.

Agenda Item 12.—Extension of the Work of the Department—Decisions of Government in Regard to.

Sessional Paper I—1928, had been circulated to members.

Agenda Item 13.—Diseases of Pineapples.

Mr. Graham Pandittasekera brought up the question of the brown discolouration of the flesh of apparently sound pineapples.

Dr. Small said that no fungus had been found associated with the condition described but he would ask Mr. Pandittasekera to send up specimens for further examination. This Mr. Pandittasekera promised to do.

T. H. HOLLAND,
Secretary.
Estates Products Committee.

Departmental Notes.

Progress Report of the Experiment Station, Peradeniya.

For the Months of May and June, 1928.

Tea.

A FURTHER examination of the tea in the Hillside Tea where alternate strips are clean weeded and planted with *Indigofera endecaphylla* reveals no perceptible difference in the appearance of the tea under these treatments.

In the nursery experiment in which two beds were planted with tea seed through Pabco mulch paper and two in the ordinary way the germination of the seed was very poor:—

Pabco beds	31%
Non-Pabco beds	35%

At 4 months old there was very little difference in the growth or appearance of the plants. The average height of the plants in the pabco beds was ·2 inches higher than that of the plants in the non-pabco beds. It would appear from this small experiment that the only advantage to be gained in the nursery is a saving in watering, but the cost of the material would more than balance any such saving.

Rubber.

Tapping of the 98 trees of budded rubber in plot 165 was started on May 1st. Individual yields of dry rubber are being recorded.

The Brown Bast Exhaustion Theory Experiment was discontinued after the trees were examined by the Physiological Botanist, Rubber Research Scheme, in May. The result of the experiment has been included in the report on tapping experiments.

A consignment of bud-wood from proved mother trees was received from a Java estate but the wood arrived in very bad condition and no successes were obtained.

Another consignment was received from Prang Besar Estate, Kuala Lampur. Most of this bud-wood was also in a bad state but out of 266 buds put on 29 successes were recorded at the first examination.

Budding for the formation of a bud-wood nursery has also been done from the following high yielding trees:—

Lavant	No. 28
Hillcroft	No. 44
Heneratgoda	No. 2
,,	No. 401
,,	No. 445
,,	No. 439
,,	No. 48
,,	No. 11
,,	No. 149
Wawulagala	No. 197
Milleniya	No. 162

An examination was made of the budded plants in plot 174 planted in an experiment to ascertain the influence of stock on scion. Out of 400 plants 104 stocks have died while in 9 other cases the bud has died but the stock is alive. The percentage of losses is as follows:—

		Stocks died.	Buds died.
H 2 Stocks	...	14%	1%
P 7 Stocks	...	23%	2%
P 5 Stocks	...	27%	0%
P 12 Stocks	...	33%	4%
P 41 Stocks	...	36%	4%

These figures are of interest since it has been previously recorded that stumps of H 2 and P 7 have always stood out superior to other stocks in the nursery. Both P 12 and P 41, though fair yielders, are poor trees. The percentage of failures from budding in the nursery on to stocks of these trees stood in the same order as that now recorded for losses of stocks after planting out, and this serves to demonstrate that, whatever the influence of the stock on the yield of the budded product may be, the selection of stocks for budding is a matter of importance, and records should be kept to ascertain what trees produce the best stocks for the purpose.

To fill vacancies in this plot a few budded stumps were planted out when the bud-shoot was about a foot long. In each of these cases, where the stock was

the bud-shoot died right back but usually sprouted again from the base. If a plant is to be put out after the bud has shot it appears advisable to plant before much growth has been made. Generally it would appear that planting before the bud has shot is preferable.

In a few cases the bud had been buried by movement of earth but the bud was shooting normally and growing upwards. It thus appears that it is possible to bury the bud so that the junction between stock and scion is underground.

Plot 77 B has been planted with stumps to be budded on later from two promising mother trees on the station.

Cacao.

Forty cacao plants were budded with a view to filling vacancies in the Economic collection with definite types of cacao. There were no failures and budding will in future be adopted for vegetative propagation of cacao instead of gootee layering from which very little success has been obtained.

Coconuts.

The young palms of different varieties in two plots on the river bank were manured with a mixture of basic slag and sulphate of potash left over from other experiments.

Fodder Grasses.

It has been decided to uproot the plot of *Paspalum commersonii* and replace this grass with Guatemala grass, *Tripsacum laxum*.

Cassava.

Cuttings of two high yielding varieties have been received from the Serdang Experiment Station, F.M.S. These are all growing well.

Soil Erosion Experiments.

In Area A the second year of the experiment came to an end on May 31st, 1928. There are 6 plots of 1/35 acre each, all planted with tea and gliciridia. In the first year records of erosion were taken without any treatment being applied to any of the plots. At the beginning of the second year plots A 1 and A 3 were planted with *Indigofera endecaphylla*, in plots A 2 and A 4 contour hedges of *Clitoria cajanifolia* were planted, while plots A 3 and A 6 were left as controls.

Since the amount of erosion from each plot will vary it is necessary to make comparison between the wash from the Indigofera and Clitoria plots relative to the control plots before and after treatment.

The actual losses of dry soil from these plots for the two years in question are given below:—

1926-27

Similar conditions in all plots.

	lb. oz.
A 1	256 5
A 2	631 12
A 3	516 9
A 4	481 13
A 5	424 0
A 6	347 4

2657 11 = 6·9 Tons per acre.
= ·05 inch of surface soil.

1927-28

A 1 and A 3 Indigofera.
A 2 and A 4 Clitoria hedges.

	lb. oz.
A 1	593 3
A 2	1206 9
A 3	925 1
A 4	945 4
A 5	863 1
A 6	885 14

5419 0 = 14·1 Tons per acre.
= ·11 inch of surface soil.

The calculation as to depth of surface soil lost is based on the assumption that 2,500,000 lb. of soil is equal to 9 inches of surface soil over an acre.

The first point that strikes the eye is that in the second year the erosion in every plot has been approximately double that of the first year. The rainfall for the two periods was as follows:—

		1926-27 Inches.	1927-28 Inches.
June	...	7·45	7·31
July	...	10 79	6·91
August	...	5·49	1·21
September	...	4·95	10·10
October	...	8·43	11·18
November	...	10·57	8·10
December	...	3·48	5·64
January	...	10·02	4·78
February	...	1·79	3·17
March	...	5 37	2·98
April	...	6·83	16·10
May	...	12·12	3·47
		87·29	80·95

The total rainfall gives no indication of the reason for the increase in erosion. Erosion depends on the intensity of the precipitation and not on the total fall. In the two periods falls of over 2 inches in a day took place as shown below.

1926-27.

		Inches
May 17th, 1926	...	2·78
October 15th, 1926	...	3·61
November 3rd, 1926	...	2·75
December 21st, 1926	...	2·17
April 30th, 1927	...	2·12
May 1st, 1927	...	2·98
May 29th, 1927	...	2·92

1927-28.

		Inches
October 20th, 1927	...	2·26
October 21st, 1927	...	2·04
October 29th, 1927	...	2·10
November 5th, 1927	...	2·65
December 27th, 1927	...	2:03
January 25th, 1928	...	2·26
April 11th, 1928	...	2·40

These figures however give no more information as to the cause of the increased erosion as ordinary rainfall figures are no guide to the intensity of rainfall.

It is now necessary to examine the effect of planting Indigofera in plots A 1 and A 4 and Clitoria hedges in plots A 2 and A 5.

1926-27.

	Indigofera Soil lost.		Control Soil lost.	
		lb. oz.		lb. oz.
	A 1	256 5	A 3	516 9
	A 4	481 13	A 6	347 4
Total		738 2		863 13

1927-28.

	Indigofera Soil lost.		Control Soil lost.	
		lb. oz.		lb. oz.
	A 1	593 3	A 3	925 1
	A 4	945 4	A 6	885 14
Total		**1538 7**		**1810 15**

Excess of erosion in control plots over Indigofera plots 1926-27 (before planting Indigofera) =125 lb. 11 oz.=14%. Excess of erosion in control plots over Indigofera plots 1927-28 (after planting Indigofera) 272 lb. 7 oz.=15%. Decrease in comparative erosion after planting Indigofera =1%.

1926-27.

	Clitoria hedges Soil lost.		Control Soil lost.	
		lb. oz.		lb. oz.
	A 2	631 12	A 3	516 9
	A 5	424 0	A 6	347 4
Total		1055 12		863 13

1927-28.

	Clitoria hedges Soil lost.		Control Soil lost.	
		lb. oz.		lb. oz.
	A 2	1206 9	A 3	925·1
	A 5	863 1	A 6	885 14
Total		2069 10		1810 15

Excess of erosion in Clitoria plots over Control plots 1926-27 (before planting Clitoria hedges) =191 lb. 15 oz.=18%. Excess of erosion in Clitoria plots over Control plots 1927-28 (after planting Clitoria hedges) =158 lb. 11 oz.=8%. Decrease in comparative erosion after planting Clitoria hedges =10%.

Compared with the control plot the planting of Indigofera has in the first year only resulted in a saving of 1% of erosion. The creeper however has made poor growth, particularly in A. The actual operation of planting also probably caused a temporary increase in erosion. Data for several years will be required before definite results are obtained.

The *Clitoria cajanifolia* hedges came away well from the start and even in their first year have effected a 10% reduction in erosion.

Nitrification Experiment.

An experiment has been laid out in collaboration with the Agricultural Chemist to record the changes over a year in nitrate content of soils

1. Limed.
2. Cultivated two monthly.
3. Manured with Muriate of potash and Superphosphate.
4. Planted with sugar cane.
5. Planted with Tephrosia candida.

Factory.

The conversion of part of the present store into a factory for cacao and rubber and the building of an additional cacao and coffee curing room has been completed. Only the new smoke house now remains to be built.

The Iriyagama Division.

The whole of the first area of 10 acres to hold 10 clones of 120 trees each has been holed, terraced, and planted with stumps to be budded in the field at a future date. In addition 2,000 stumps have been planted in a nursery to form the stocks for a future bud-wood nursery.

Centrosema has been planted over more than half the area and is coming on well.

T. H. HOLLAND,
Manager,
Experiment Station, Peradeniya.

Bogamuwa Paddy Cultivation Competition 1927-28.

There were 25 members who entered for a paddy cultivation competition organised by the Bogamuwa Co-operative Society during the Maha season of 1927-28.

Most of the fields were ploughed thrice, while some were partly dug. Despite the unfavourable weather conditions 20 of the competitors weeded their fields and supplied vacancies.

As a direct result of competitions of this kind there is observed a distinct improvement in the paddy cultivation in the locality.

The following were awarded prizes:

1. K. G. Punchi Naide	... Rs.	25·00
2. H. Hendric	... ,,	20·00
3. P. B. Bogamuwa	... ,,	15·00
4. Jamis Singho Vidane	... ,,	12·50
5. N. A. Punchi Singho	... ,,	10·00
6. Kalu Naide	... ,,	7·50
7. S. A. Appuwa	... ,,	5·00
8. G. Nelis Fernando	... ,,	5·00

Kurunegala Town Paddy Weeding Competition.

A paddy weeding competition which was open to cultivators and landlords of Kurunegala Town was held during the Maha season of 1927-28.

There was keen competition among the 21 cultivators who entered the competition. The fields were ploughed thrice, and some were partly dug with mammoties, while one competitor manured his field with fish manure.

The ridges were also cleared and neatly kept throughout the season. Vacancies were supplied in all cases, and some transplanted their fields.

The following were awarded prizes:—

1. Galagedara Horatala	... Rs.	25·00
2. Watte Horatala	... ,,	20·00
3. K. H. Bilinda	... ,,	15·00
4. Watte Kalunda	... ,,	12·50
5. K. H. Balaya	... ,,	10·00
6. Pina	...	7·50
7. K. K. Bandiya	...	5·00
8. K. H. Muthuwa	... ,,	5·00

Hiriyala Hatpattu Paddy Cultivation Competition.

A paddy cultivation competition was held in the Hiriyala Hatpattu of the North-Western Province during Maha 1927-28, when 19 competitors entered.

The unfavourable weather conditions were a hindrance to satisfactory cultivation, and many were prevented from entering the competition owing to the scarcity of water.

The preparatory tillage was very well done and green manuring was resorted to by a few of the cultivators, while two cultivators folded cattle in their fields and another applied cowdung.

The following are the prize winners:—

1. A. Podisingho	... Rs.	25·00
2. H. M. P. Banda	... ,,	15·00
3. H. H. B. Dasanayake	... ,,	10·00

Walapane Chillie Cultivation Competition.

A chillie cultivation competition was held in the Walpane Division of the Nuwara-Eliya District. It was widely advertised by the Agricultural Instructor and the headmen, and the competition was keenly contested, there being forty-nine entrants from various parts of the division.

The preliminary judging was done by the Agricultural Instructor who assisted the cultivators at all times with helpful advice, and the final judging was done by the Divisional Agricultural Officer.

The following were awarded prizes and departmental certificates :—

1. Tunpelegedera Wannukurala of Padupola ... Rs. 40 ·00
2. Miriswatte Gunanhirala of Udawela ... Rs. 20 ·00
3. Mahawatte Siribaddena of Ambaliyadde ... Rs. 10 ·00

Book Review.

"Wood Rot in Tea."

The Department of Agriculture has been favoured with copies of pamphlets entitled "Wood Rot in Tea—its Cure and Prevention" and "Skene's Enamel Wax Treatment for Wood Rot in Tea" published by the *Times of Ceylon.*

The pamphlets should be of interest to all connected with the Tea Industry in Ceylon, and the details contained in them in regard to the cause and treatment of Wood Rot are of value. They advocate the employment in the treatment of Wood Rot Skene's Enamel Wax, an article which has been experimented with on a large number of estates.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1928	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	46	11	4	34	3	5
	Foot-and-mouth disease	1737	601	1492	4	241	...
	Anthrax	...	...	...	...	...	...
	Piroplasmosis	6	...	5	1	...	...
	Rabies (Dogs)	1	...	...	...	...	1
Colombo Municipality	Rinderpest	253	120	7	209	36	1
	Foot-and-mouth disease	253	...	244	9	...	...
	Anthrax	1	...	...	1	...	...
	Rabies	7	3	...	...	...	7
Cattle Quarantine Station	Rinderpest	77	6	39	34	4	...
	Foot-and-mouth disease	72	4	68	4	...	...
	Anthrax	...	...	...	...	...	...
Central	Rinde pest	...	...	...	...	...	...
	Foot-and-mouth disease	96	19	77	...	19	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	4	1	...	...	...	4
Southern	Rinderpest	F R	E E				
	Foot-and-mouth disease						
	Anthrax						
Northern	Rinderpest	F R	E E				
	Foot-and-mouth disease						
	Anthr						
Eastern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	172	56	160	...	12	...
	Anthrax	...	...	...	...	...	...
North-Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	2907	2189	2288	23	594	2
	Anthrax	...	...	...	...	...	...
	Piroplasmosis						
	Rabies (Dogs)						
North-Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	648	350	336	2	310	...
	Anthrax	...	...	...	...	...	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and mouth disease	10	...	10	...	...	...
	Anthrax	...	...	...	...	...	...
	Piroplasmosis						
	Rabies (Dogs)						
Sabaragamuwa	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1749	902	1363	20	366	...
	Anthrax	...	...	...	...	...	...

Colombo, 9th July, 1928.

G. W. STURGESS,
Government Veterinary Surgeon.

JUNE, 1928.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction During Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	81·9	+0·8	80	8·6	SW	168	8·92	20	+ 0·65
Puttalam	83·4	+1·6	76	6·1	SW	259	0·43	5	— 1·28
Mannar	86·0	+1·5	72	5·8	SSW	261	0·00	0	— 0·54
Jaffna	83·9	+0·4	78	5·0	SW	370	0·00	0	— 0·65
Trincomalee	86·4	+0·8	64	5·5	WSW	276	0·08	2	— 1·18
Batticaloa*	85·7	+0·4	66	3·6	—	143	0·00	0	— 0·96
Hambantota	83·0	+1·4	76	5·4	WSW	357	0·93	12	— 1·47
Galle	81·0	+0·4	82	8·1	WNW	294	7·02	24	— 1·35
Ratnapura	81·6	+1·0	82	7·5	—	—	18·68	28	— 1·23
Anu'pura	84·7	+1·5	64	6·4	—	—	0·00	0	— 1·30
Kurunegala	81·6	+0·7	78	8·8	—	—	6·12	19	— 1·92
Kandy	77·6	+1·0	76	6·8	—	—	6·37	20	— 3·03
Badulla	75·8	+0·4	76	5·0	—	—	0·45	3	— 1·78
Diyatalawa	71·2	+0·6	66	6·2	—	—	0·11	3	— 1·91
Hakgala	64·1	+2·1	81	5·6	—	—	4·56	19	— 3·21
N'Eliya	61·2	+1·1	82	9·4	—	—	8·76	25	— 3·89

* (Observations taken for 17 days only)

The rainfall of June was decidedly below average over nearly the whole island and particularly in the Central Province. Up to the 28th deficits were even more pronounced, but heavy rain in the last two days of the month reduced them somewhat, and in the case of a few stations chiefly in or near the Kelani Valley, brought the total for the month up to average. The highest figures for a single day were Kanangama 9·75, Ingoya 9·55, and Yatiyantota 9·15 all on the 30th, on which day falls of over 8 inches were recorded at Carney, Digalla, Dunedin, Geekianakanda, Keragala, Kitulgala, and Maliboda.

The highest totals for the month were at Watawala 33·89, Ingoya 30·14, though these were below their June averages by eight and twelve inches respectively.

Stations at which no rain was recorded included nearly all those in the Jaffna Peninsular and about half of those in the remainder of the N. P., and in the N. C. P. and E. P.

The pressure gradient was distinctly steeper than usual and as a result the wind strength was above average. This was particularly the case in the first half of the month at some of the up-country stations, *e.g.*, Hope (Hewaheta) and West Haputale. There was however a noteworthy drop in the wind mileage before the period of increased rainfall commenced.

A. J. BAMFORD,
Supdt., Observatory.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st JULY, 1928.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st. 1928	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	99	53	12	69	13	5
	Foot-and-mouth disease	2384	647	2098	6	280	...
	Anthrax	...	...	...	...	...	...
	Piroplamosis	6	...	5	1	...	...
	Rabies (Dogs)	1	...	...	...	...	1
Colombo Municipality	Rinderpest	386	133	25	336	24	1
	Foot-and-mouth disease	260	7	249	9	2	...
	Anthrax	1	...	...	1	...	...
	Rabies (Dogs)	12	5	...	...	...	12
Cattle Quarantine Station	Rinderpest	77	...	43	34	...	...
	Foot-and-mouth disease	74	2	70	4	...	...
	Anthrax	...	...	..	...	...	...
Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	556	460	136	4	416	...
	Anthrax	...	...	...	...	...	...
	Rabies Dogs)	5	1	...	...	...	3
Southern	Rinderpest	F R	E E				
	Foot-and-mouth disease						
	Anthrax						
Northern	Rinderpest	F R	E E				
	Foot-and-mouth disease						
	Anthrax						
Eastern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	285	113	240	...	45	...
	Anthrax	...	...	...	...	...	...
North-Western	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	3471	564	3178	30	261	2
	Anthrax	...	...	...	...	...	...
North-Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1421	773	873	13	535	...
	Anthrax	...	...	...	...	...	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	10	...	10	...	...	...
	Anthrax	...	...	...	...	...	...
Sabaragamuwa	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	2107	358	2015	34	58	—
	Anthrax	...	..	...	...	...	...

G. V. S. Office,
Colombo, 8th August, 1928.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL

JULY, 1928.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	81·3	+0·9	79	9·0	WSW	165	5·65	10	— 0·87
Puttalam	81·0	—0·1	82	6·2	SW	213	14·00	4	+13·40
Mannar	83·6	+0·4	76	8·4	S	219	0·96	6	+ 0·58
Jaffna	82·2	—0·3	80	6·4	SW	299	1·99	5	+ 1·12
Trincomalee	83·2	—1·5	69	7·3	WSW	232	2·12	5	+ 0·06
Batticaloa	83·9	—0·7	66	6·4	WSW	135	1·99	6	+ 0·77
Hambantota	83·1	+1·5	73	5·5	WSW	338	4·34	6	+ 2·59
Galle	80·5	+0·6	84	8·3	WNW	315	5·25	13	— 0·90
Ratnapura	81·0	+0·6	78	7·6	—	—	12·69	21	— 0·07
Anu'pura	81·8	—1·4	79	7·4	—	—	4·72	5	+ 3·45
Kurunegala	80·6	0	78	9·0	—	—	6·77	11	+ 2·68
Kandy	77·4	+1·6	74	7·5	—	—	12·37	17	+ 4·90
Badulla	74·2	—1·1	77	5·8	—	—	6·05	6	+ 4·07
Diyatalawa	70·0	—0·1	64	8·0	—	—	4·90	7	+ 2·96
Hakgala	63·3	+1·5	82	5·4	—	—	9·80	14	+ 2·90
N.' Eliya	60·5	+1·5	80	9·0	—	—	13·33	19	+ 1·33

The total rainfall of July was above average over three quarters of the island but was below it in the southern halves of the W.P., C.P., and Sab., and in the western half of the S.P.

This result was chiefly due to heavy rain from the 5th to 11th, and particularly on the 6th and 7th. The cause appears to have been, not a simple strengthening of the monsoon, but the interaction of the monsoon and a mild depression with centre east of the island, which resulted in some unusual wind directions for this time of year and in the rain not being confined to areas in which it is common in July. The heviest falls in a day, several of which were of over eleven inches, occurred at stations slightly inland from the west coast from Puttalam to Heneratgoda inclusive. From the 13th onwards conditions were comparatively dry and from the 17th to to the 25th particularly so.

The highest totals for the month were Padupola 30·54 inches, and Kenilworth 29·18, which were above their averages by 1·7 and 0·3, respectively, while the next highest, Blackwater, with 28·19 was about 5 inches below its average. The highest offsets above average were mostly in quite different areas *e g.* Liddesdale with 17·7 was 15·9 above, while Puttalam and Madurankuli with totals of less than 15 inches were over 13 above.

A. J. BAMFORD,
Supdt. Observatory.